

Olympic TechTHE GEAR THAT HELPS
ATHLETES WIN GOLD **P 56****6 Fun Cars**GREAT PERFORMANCE
& MPG—REALLY! **P 64****DIY Pergola**THIS IS THE SUMMER TO
BUILD ONE **P 92****08.12**Volume 189, No. 8
PopularMechanics.com

Popular Mechanics

ANOTHER
REASON
WE'LL MISS
CARROLL
SHELBY:
THE 662-HP
GT500 **P 35**

How To Mine An

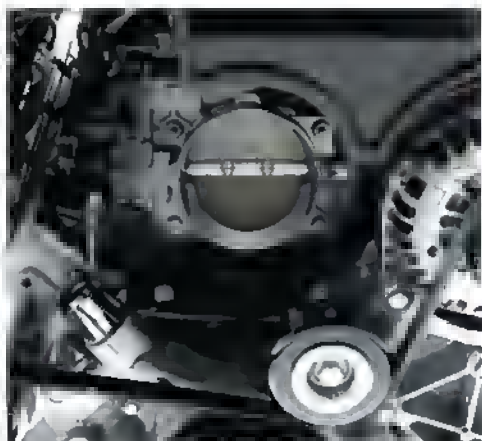
Why top tech moguls are betting on space prospecting
as a multibillion-dollar business **p 50**

Asteroid

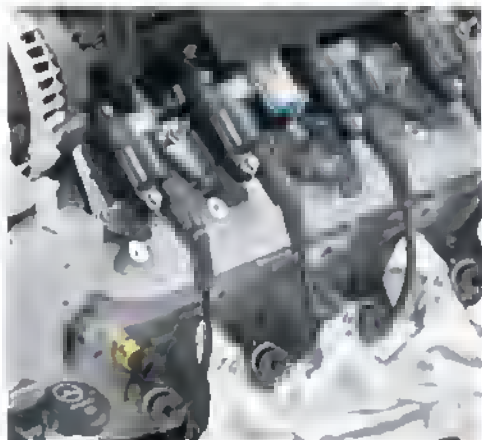
Claim Your Rock,
Extract Precious
Resources, and Build Your Space Colony!**Your DIY Life:**Shoot Photos Like a Pro,
Replace a Car Window, Fight a
Facebook Hack, Build a Catapult,
Cook a Damn Good Steak on a
Campfire, and More **Starting on p 79**

SINCE 1902

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IGNITION

The Olympian-worthy Cervélo P5's aerodynamics help cyclists reach for gold.



INSIDE

IGNITION

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A visionary new company prepares to cull precious resources from space rocks. Is the next step colonization? BY MICHAEL BELFIORE 50

Olympic Science In the quest for gold, even the most gifted athletes can gain an edge from high-tech gear. BY JOE LINDSEY 56**Family Values** American carmakers aim for domestic dominance with a sharp set of compact sedans. PM tests the U.S. against the rest. BY BEN STEWART 64**Life at the Epicenter** How do you prepare for the unpredictable? When it comes to earthquakes, you don't just roll with it. BY KALEE THOMPSON 70

08.12

ON THE COVER

It takes a village to mock up an asteroid-mining scenc. We had the body sculpted out of fossilized rock, then assembled the mining site with tiny structures from Xmarx. Since the two parts were different in scale, Plamen Petkov photographed them separately. Last but not least, POPULAR MECHANICS' digital artist Anthony Verducci melded the images to create the finished product. Phew!



PopularMechanics

W
weekend

25 Pages of DIY



80. Tech

Your 3D TV has arrived. Here's how to get the most out of it—for less.

Tactics 20 Ways to Take a Better Photo

Digital Clinic Responding to a Facebook hack



90. Adventure

The tools and techniques to grill the perfect steak while on the trail.



92. Home

A simple, blissful addition to any yard: how to build a pergola in eight steps.

Tool Test String trimmers

Early Adopter Project for kids: Build a catapult!

Home Clinic Vacation-cabin security



104. Science

A pair of binoculars and a star chart are all you need to explore the cosmos from your backyard.



106. Auto

Spare yourself the insurance headache and replace a broken side window yourself.

Car Clinic Why the Chevy Volt is all that.

COMPLAINTS DEPARTMENT

"It's time for PM to get out of the 1900s! I'm offended by the favoritism toward men over women in the magazine. Women are mechanics, engineers, and tinkers, too, but they are rarely featured in your pages. Are you trying to appeal to people interested in DIY—or just the antiquated idea of an all-male crowd?" **TABITHA BELSHEE, ESCONDIDO, CA**



?#@*8%!



What You Said

(ABOUT OUR JUNE ISSUE AND MORE)

We read all of your comments, tweets, and letters to PM. Love the perpetual-motion-machine blueprints. Keep it up!

CURATED BY ALYSON SHEPPARD

TALK TO US

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Dave Rooney of Dublin reads PopMech on his iPad inside the Luas light-rail system's central control room. "We're big fans of PM," he writes.

Our June cover story, "The Big Play," and Editor's Note, "Drilling for Facts," surveyed the boom in American oil production, focusing on North Dakota's super-productive Bakken Formation. ● Robert Rudd of Houston said our articles were spot-on. "PM is the first mainstream publication to present the unbiased facts," he wrote. "I applaud your honesty and recognition of the realities of the energy industry in the U.S." ● Jim Bayles of Nazareth, Pa., agreed: "Your coverage was much more complete than what's in business magazines." ● But Mitch Scheele of Albany, Ore., said we failed to include the influence of Wall Street speculators on the price of oil and gas. ● Marc Comstock of Reno, Nev., warned against characterizing the Bakken production as an oil boom. "The new oil





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should be seen as a reprieve," he wrote. "It's just buying us time to develop long-term alternative energy sources." ● David Heafey of Tewksbury, Mass., thought our narrative was "exceptional" and was awestruck by the photos. "The images of the enormous pumpjack machines working against a cloudy sunrise say it all: an unspoken future, tempered with hope."

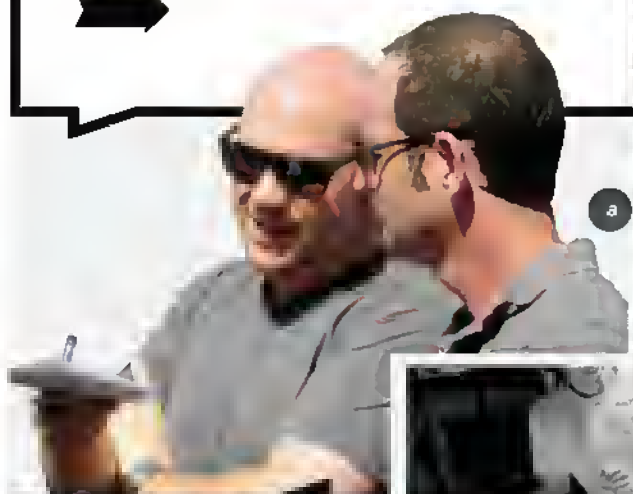
● **Sharing the PopMech Wealth** I always see the letters from folks who read the magazine when they were kids and I wanted you to know: It continues on with the current generation! I've been a dedicated subscriber for years. My son is in the seventh grade, and as soon as PM comes in the mail, it does a disappearing act into his room. I eventually get it back . . . weeks later with all kinds of dog-eared pages. But it did help inspire his award-winning science project this year, so I guess I'll just need to wait my turn each month. **DEB LAGANA, PORTLAND, CT**

Sean Hannan, 4 (left), of Dayton, Ohio, made his bottle rocket (Early Adopter, June) with his dad, James. "Nothing could prepare Sean for the thrill of seeing it in action!" James writes.

WHAT YOU SAID

What We're Up To

(PM NEWS & EVENTS & STAFFERS ON THE SCENE)



We're really busy in August

AUG. 5: NASA's Curiosity rover lands on Mars (expected)
AUG. 5: Nascar's Pennsylvania 400, Pocono Raceway
AUG. 11-12: Perseids meteor shower (midnight)
AUG. 21: Counter-Strike: Global Offensive released



(a) Assistant editor Andrew Del-Colle [left] and West Coast editor Ben Stewart compare notes at our compact-sedan test ["Family Values," p. 64]. (b) Our art/photo/interactive team celebrate winning a gold Award of Excellence at the Society of Publication Designers' 47th annual awards event. Clockwise from top left: Mike Ley, R. Scott Wells, Ed Manning, Spencer Lloyd, Julia Knetzer, Michele Ervin, and Anthony Verducci. (c) Online editor Andrew Moseman plays the "banana piano" at the Bay Area Maker Faire.

IGNITION

!

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Employee of the Month

When **Peter Herbert** isn't designing our award-winning pages, he's shutting his two daughters to gymnastics and piano recitals. The Welshman gardens and does yoga to preserve his unwaveringly calm demeanor.

IGNITION

"How do deep-sea creatures survive at depths that can crush a car?"
Dan S., 13, Rockledge, FL

Lisa Levin, distinguished professor at the Scripps Institution of Oceanography, says it all comes down to the gases. "High pressure acts strongly to compress gas, but tissues and fluids are less affected," she says. "Most animals living at high pressure in the deep sea don't have any gas spaces." The fish that do—such as some kinds of angler fish—can adjust the gas in their swim bladders to keep them from imploding. Conversely, bringing a deep-sea creature to the surface can kill it, Levin says. — *Steve Rousseau*



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ON THE WEB

This month on PopMech.com, view the wildest mutant vehicles from Burning Man (including one that looks like a nautilus shell), pick your favorite sci-fi faster-than-light transportation, and read these great stories:

DIY POWERHOUSE

The oscillating multitool has won over a legion of do-it-yourselfers with its versatile talents. Here are 10 household jobs this capable tool can handle with ease.

popularmechanics.com/multitool

HOT CARS FOR 2013

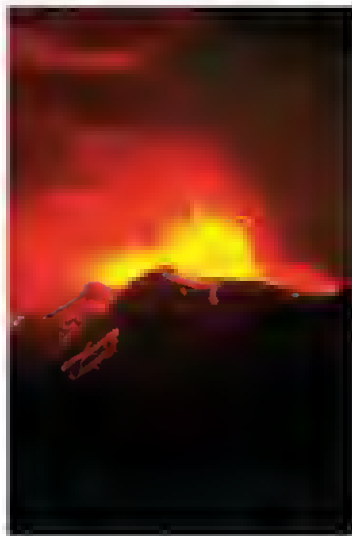
Fuel economy may rule the day, but there is plenty of style and performance in new cars. The 2013 models worth waiting for include the Dodge Dart R/T, the next Corvette, the Subaru WRX, and more.

popularmechanics.com/2013cars

RUMBLING VOLCANOES

The 17,802-foot stratovolcano Popocatepetl, located near Mexico City, has been restless recently. It's not alone. These seven volcanoes, including Italy's Etna and Iceland's Katla, could be on the verge of new eruptions.

popularmechanics.com/volcanoes



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Tech WATCH

NEWS

TRENDS

BREAKTHROUGHS

1



TECH CULTURE

Batman's New Ride

Work on Christopher Nolan's Batman movies always starts with the superhero's vehicle. For *The Dark Knight Rises*, out July 20, production designer Nathan Crowley Incorporated features from military aircraft—including tilt-rotors and jump jets—to create the Bat. The pitch of the rotors under the frame enables the Bat to move forward, and it hovers by venting jump-jet exhaust through its body. "We had to push ourselves to make something that was very believable," Crowley says. Special effects supervisor Chris Corbould constructed two Bats and built rigs (erased in post) to make it look like they were flying.

F-35B

"If you have enough horsepower, you can make almost anything fly."

— MIKE SKAFF,
LOCKHEED MARTIN
ENGINEER



COULD IT REALLY TAKE OFF?

The Bat is inspired by Lockheed Martin's short-takeoff and vertical-landing warplane, the F-35B. The Bat's ducted fans, mounted on arms, swivel down to hover, similar to

the way the F-35B's engine nozzle changes orientation. Mike Skaff, chief engineer for F-35 pilot-vehicle interface, says the Bat's multiple flight-control surfaces and ducted fans are

not that far-fetched. "There's a lot of Hollywood in it," Skaff says. "But that's not to say that we can't [invent tech that will] levitate such a vehicle."

— ERIN MCCARTHY



RENEWABLE ENERGY

GROOVES FUNNEL WIND TO INCREASE ITS SPEED

TURBINES SPIN



Squeeze Play

No disrespect to veteran ballplayer Shin-Soo Choo, but the Cleveland Indians decided they needed more power in right field. Working with engineers at Cleveland State University, Progressive Field's owners installed a corkscrew-shaped structure in the stadium housing four mini turbines that are expected to generate 25,000 kilowatt-hours of electricity per year. The design funnels wind into the turbines, allowing them to generate power on even relatively calm days. This will augment energy from solar panels installed at the stadium in 2007. — ALEX HUTCHINSON



NEWS BRIEF

Brain Freeze Basics

MYSTERY: What causes the brief, flaring headaches that plague ice cream eaters?

METHODOLOGY: Researchers working with the Department of Veterans Affairs, seeking ways to treat headaches caused by explosions, used ice water to trigger headaches in 13 volunteers. The researchers monitored the blood flow to the brain using transcranial Doppler imaging.

EXPLANATION: Pain started when the anterior cerebral artery dilated and sent a rush of blood to the brain, presumably in an attempt to keep it warm. Soon after, the artery constricted once again, relieving the pain by allowing the pressure in the brain to drop. The researchers speculate that other, more serious types of head pain, such as migraines, could be triggered by a similar mechanism; if so, drugs that alter the brain's blood flow could offer new treatments. — A H



TECH WATCH

ELECTRONICS

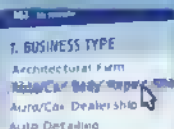
One million counterfeit parts from China were found in U.S. military hardware by Senate Armed Services Committee investigators. "Counterfeiters are becoming better at shielding their dangerous fakes from detection," says Sen. John McCain, the committee's ranking member.

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THE HARDWARE

Space Exploration Technologies' Falcon 9 rocket and the Dragon space capsule.

WHY IT MATTERS

SpaceX became the first private company to design and launch a craft carrying cargo to the ISS. The cost savings over government programs may open space to a variety of commercial ventures.

THE LAUNCH

The Falcon 9 rocket rolls onto the launchpad at Cape Canaveral Air Force Station in Florida. NASA monitors the flight from launch centers in Houston and Florida; SpaceX employees from their headquarters in Hawthorne, Calif.



3:53 am

The Dragon separates from the rocket's second stage; minutes later the spacecraft's solar arrays deploy (above).

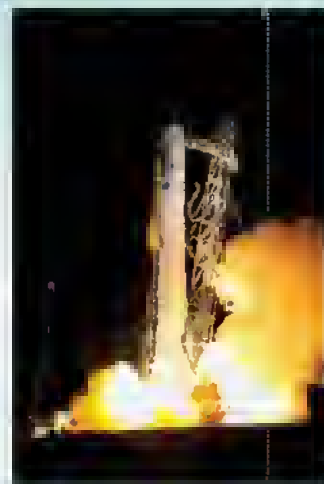
3:47 am

First stage separation.

3:45 am

"Vehicle is supersonic."

— SPACEX MISSION CONTROL, HAWTHORNE, CALIF.



3:44 am ET

Falcon 9 launches from Cape Canaveral with a thrust of 1.1 million pounds per foot.



TECH WATCH

GLOSSARY

- KEEP-OUT SPHERE** A 656-foot-diameter circle around the International Space Station where spacecraft access is tightly controlled to avoid collisions with the station.

57.7-FOOT ROBOTIC ARM

THE RENDEZVOUS

THE RETURN

May 24

After firing its thrusters to catch up with the ISS in co-elliptical orbit, the Dragon performs tests to prove it can maneuver reliably, then closes the gap to 1.5 miles. The two craft are moving at about 17,500 mph.

May 25 9:45 am

Dragon crosses the keep-out sphere and halts in free drift 32 feet from the ISS. A LIDAR sensor is not working; NASA's mission control reminds the ISS crew that if the other fails the mission will abort.

9:47 am

"The crew is ready for Dragon capture."

— ISS CREW MEMBER ANDRÉ KUIPERS

9:56 am

ISS crew member Don Pettit hooks into a port on the capsule with a robotic arm. "It looks like we've got us a dragon by the tail," he says. Applause erupts in NASA's command center in Houston and SpaceX's mission control in Hawthorne.

12:02 pm

After using remote video cameras and binoculars to confirm that the capsule's seals are free of debris, the ISS crew connects Dragon with the Harmony module.

May 26 5:52 am

"You have a 'go' for ingressing Dragon."

— NASA MISSION CONTROL

5:53 am

Pettit and Kuipers, wearing respirators, open Dragon's hatch. The air inside is free of launch fumes. Pettit later says it "smells like a brand-new car."

11:08 am

Dragon jettisons its trunk and solar panels. Within 10 minutes, friction from the atmosphere begins to raise the heatshield's temperature to 3000 F.

11:35 am

Two drogue chutes deploy at 45,000 feet to stabilize and slow the spacecraft. These detach when three 116-foot-diameter main parachutes open at 10,000 feet.

May 31 5:49 am

Dragon, filled with completed experiments and 1367 pounds of unwanted gear, pushes away from the robotic arm with three departure burns.

11:26 am

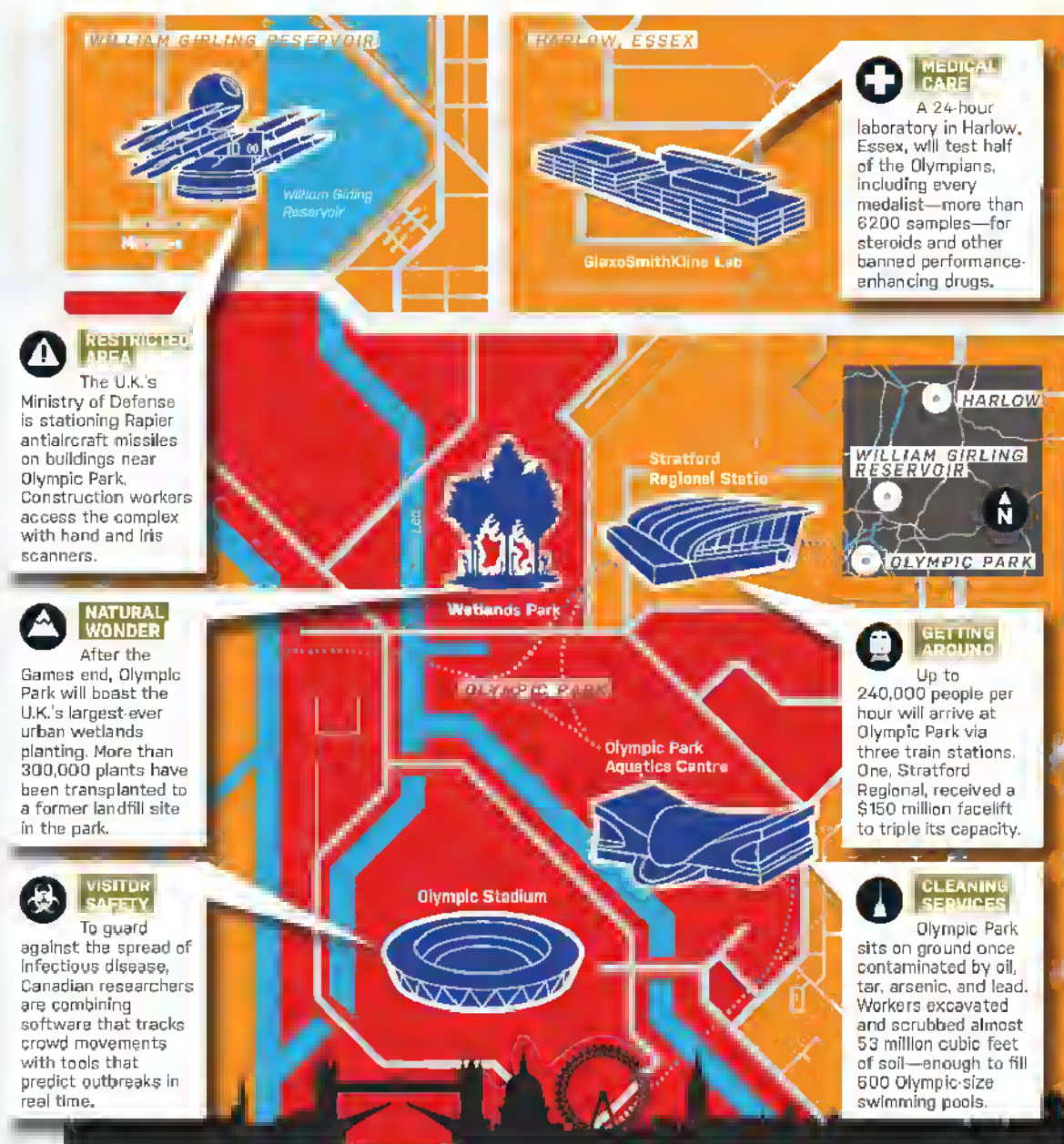
Hot plasma blocks communication with the capsule as it burns through Earth's atmosphere.

11:42 am

The capsule splashes down in the Pacific, about 500 miles off the coast of Baja California. A dive team dispatched from a 185-foot barge secures the capsule; a crane lifts it to the barge's deck.



"This mission heralds the dawn of a new era of space exploration, one in which there is a significant commercial space element." — ELON MUSK, FOUNDER, SPACEX



Visitor's Guide to ...

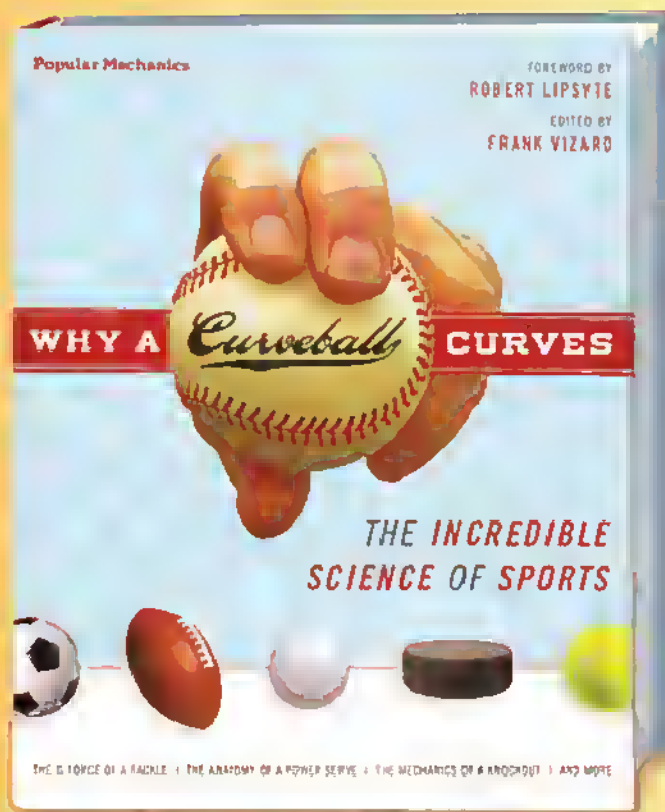
THE LONDON SUMMER OLYMPICS

Hosting the Olympics is a mammoth exercise in logistics. The Olympic Committee has spent more than \$3 billion staging the games for an estimated 11 million visitors, including transforming an industrial wasteland into the Olympic Park. Here are key upgrades the casual visitor may not be aware of. — SARAH FECHT

For more on sports technology at the Olympics, see [page 56](#).



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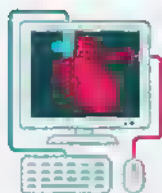
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EARTHJUSTICE.ORG/STAND



Heart attack survivors are often left with scar tissue that hinders the organ's ability to pump blood, leading to problems as serious as heart failure. Scientists at Duke University Medical Center are "reprogramming" that scar tissue into new heart muscle, using micro-RNA molecules that control gene activity in the individual cells. The new technique has been successfully demonstrated in a living mouse and may turn out to be more practical than competing approaches using stem cells. The next step is to try it in larger animals; it could take up to a decade to reach human trials. — ALEX HUTCHINSON

TECH WATCH



FLIGHT DYNAMICS

Paper of Record



B

uilding an 800-pound paper airplane is tough—but getting it airborne is even tougher, as a team led by the Pima Air & Space Museum in Arizona found out. After several false starts, including the plane bucking under its own weight, a helicopter managed to hoist the plane by its nose and then release it. The result: a glorious flight with a very, very hard desert landing. The remains of the plane—small fragments of the nose and one of the winglets—are now on display at the museum. — A.H.

STATS

Length: 45 feet
Wingspan: 24 feet
Altitude: 2703 feet
Top speed: 98 mph
Free flight: 0.93 miles
Landing: Hard



PHOTOGRAPH BY REUTERS (PLANE IN DESERT); ILLUSTRATION BY RICHARD PEREZ



NEWS BRIEF

Tunnel Vision

Water flows from as far as 125 miles away to reach New York City from upstate reservoirs, but it needs virtually no pumping because the pipes run downhill the whole way. In fact, New York's and many other urban water systems deploy pressure-reducing valves to dissipate excess pressure before the water reaches the taps of consumers. A startup called Rentricity proposes to add small turbines near those valves to generate electricity—a plan currently being studied by New York City. Rentricity turbines at a gravity-fed water treatment plant in Keene, N.H., now generate 62 kilowatts, enough to run the entire plant. New York may be a tougher sell, because real estate—aboveground and belowground—is highly congested. The feasibility report is due by the end of 2013. — A.H.



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Game On

Blasting aliens is fun, but only for so long. With all the technology available to us today—tablets! 3D TVs! Xboxes!—it's easy, tempting even, to ignore the world outside. But man was not meant to live solely in the glow of electronics. So head out into the sunlight (we know it's really bright—the pain will pass) and rediscover lawn games. You may feel a bit odd at first, flailing at a feather-light shuttlecock or hurling a 2½-pound horseshoe at a target 40 feet away, but give it time. People have been playing these games for genera-

tions (croquet, for instance, dates back to the 1850s), so this wholesome analog entertainment must have some merit. Plus, it gives you an excuse to use the John Deere to clear up the court. Paul Tukey, author of *Tag, Toss & Run: 40 Classic Lawn Games*, lays out the ground rules for three games and provides tips on how to trounce your opponent.

— JOHN BRANDON

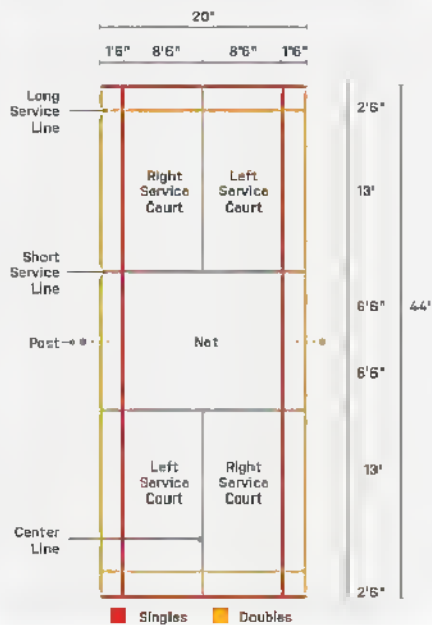
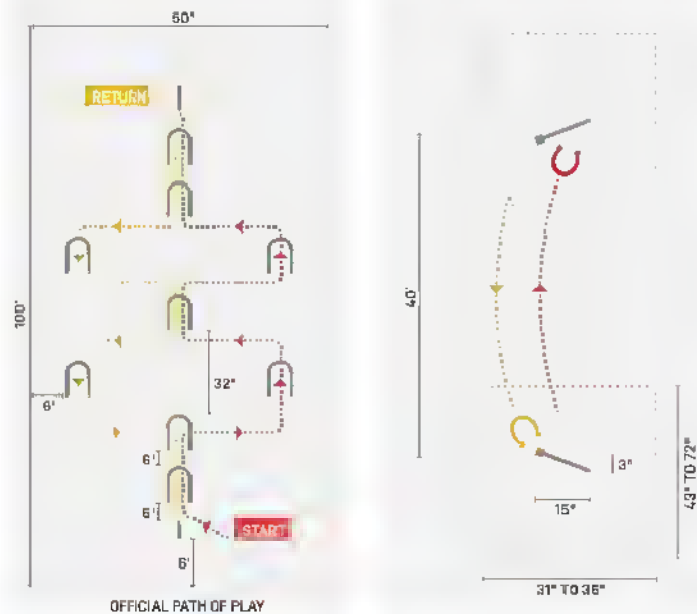
GEAR

TOOLS

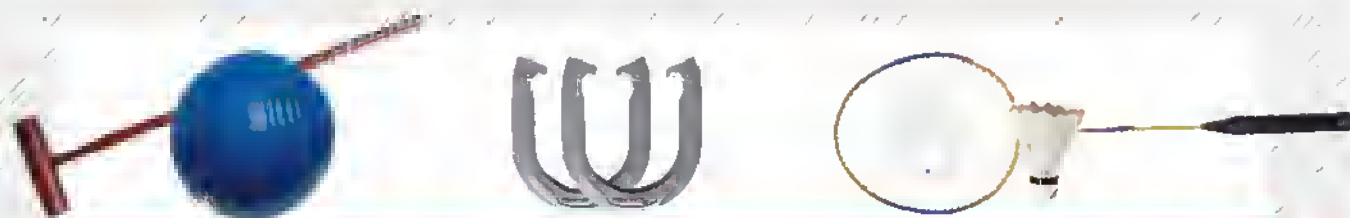
GADGETS

Upgrade

The Victorians loved lawn games. Leave it to Lewis Carroll, though, to introduce a kooky version of a classic: In *Alice's Adventures in Wonderland*, the Queen of Hearts plays croquet with a live flamingo as her mallet, a hedgehog as the ball, and bent playing cards as wickets.



DIAGRAMS NOT TO SCALE



**FRANKLIN SPORTS 6
PLAYER EXPERT CROWD
SET \$94
PLAYERS: 2 TO 6**

An extremely challenging lawn game, croquet involves hitting your own colored ball through a circuit marked with two stakes and nine metal wickets. After striking the ball through the first set of wickets, then hitting the far stake, players return to the start, where they must also hit that stake. Players hit one ball per turn. But roqueting, or hitting the ball of another player, earns you two extra strokes. First player back to the start stake wins. Master tip: It's better to leave your ball in a good position for your next shot rather than simply aiming for the wicket.



CHAMPION SPORTS
STEEL HORSESHOE SET
\$49
PLAYERS: 2 OR 4

There's more to horseshoes than good aim and a strong arm. Set up two stakes 40 feet apart. Line up beside your stake. Throw the shoe underhand, like you're pitching a softball, taking a step toward the opposing stake as you swing the shoe forward and let it fly. After two throws, the other team throws toward your stake. Games are played to 11 or 21 points. A shoe that comes to rest 6 inches or less from the stake earns one point; a ringer, with both ends around the stake, earns three points. "The best players are deadly accurate, achieving ringers on upward of 60 percent of their shots," Tukey says.



**PARK & SUN REIMBURSEMENT
PRO SET**
\$89
PLAYERS: 2 OR 4

Swoosh-whack, swoosh-whack! Ah, the sound of a badminton match on a lazy summer afternoon. Start with a serve behind the service line; score a point for landing the birdie in the playing field, whether or not you're serving. Hit the net or go over the line? You pass the serve. First player to score 21 points wins. Tukey recommends a warmup round of volleying without keeping score. Fun fact: The best birdies are made with 16 goose feathers. (Feather shuttlercocks, like the one above, can be found on amazon.com.)

GLOSSARY

CARROT

Not just a rabbit's favorite snack. In croquet, the term refers to the part of the wicket [the hoop you hit the ball through] that is inserted in the ground.

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EDITORS' PICKS 15 TOP TOOLS

Each year hundreds of products come through our doors—but only a few truly shine. Here are our choices for 2012's standouts, which we awarded at the National Hardware Show.

BY ROY BERENDSOHN

1 FISKARS SHOP BOSS HARDWARE SNIP, \$25

The Shop Boss is a hardware snip that cuts almost anything you squeeze between its titanium-coated blades: light-gauge sheet metal, screen, twine, and small-gauge electrical wire. That alone would be great, but the Shop Boss's usefulness doesn't end there. Its sheath is a tool, too: It's equipped with a pencil holder, a ceramic deburring tool, and a tape cutter.

UPGRADE
2



MCCAULEY TOOLS MINI-ROLLER FLEX, \$34

How annoying is it when you're painting and you can't reach into a corner or another awkward space? The McCauley Roller Flex solves that problem by mounting a roller on a flexible handle. Screw the tool onto a standard telescoping extension handle, bend it to the shape you need, and cover the places that only a contortionist could access.

MAKITA RT0700CX3 ROUTER, \$240

Powered by a 1½-hp motor, this Makita router is the size of a laminate trimmer but has all the features and accessories we've come to expect from tools twice its size. Its three bases and variable electronic speed control allow you to match the tool to the job.



4



RIDGID ROOFING CUTTER, \$100

Removing the edges from asphalt shingles is time-consuming and can be dangerous, so anything that makes it easier is advisable. Enter the Ridgid Roofing Cutter. Hook its blade on the shingles hanging over the rake edge, pull the lever, and go. The tool weighs just over 1 pound and slices off the excess shingles at 9600 strokes per minute, which is really, really fast.

5

TORO XTRA SMART PRECISION SOIL MOISTURE SENSOR, \$150

Often we see sprinklers running in the rain. Toro's Xtra Smart ends that waste. The sensor reads the moisture in the ground, then sends that information back to a receiver wired to the sprinkler's timer. If the soil is dry, the sprinkler runs; if it's wet, it doesn't.



The other winners:

6 BLACK & DECKER LST136 36-VOLT STRING TRIMMER 7 COAST LEO PRO POCKET PLIERS 8 DEWALT DWE357 RECIPROCATING SAW 9 KREG TOOL COMPANY RIP-CUT 10 LASKO POWER TOOLBOX MODEL 9002 11 MILWAUKEE ELECTRIC TOOL M12 COROLESS SUB-COMPACT BANDO SAW 12 MR. HEATER HERO 13 RACOR LADDER LIFT 14 SAVAGE FOLDING JAB SAW-UTILITY KNIFE 15 CRESCENT ADJUSTABLE NAIL PULLER.

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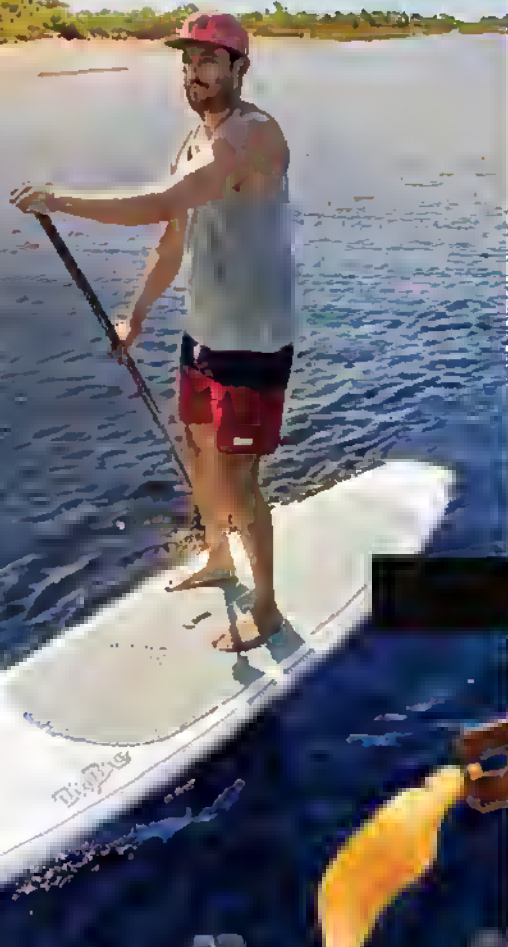
krylonrustprotector.com
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Make It Yours®

JIMMY STYKS BIG BRO STAND-UP PADDLE BOARD PACKAGE \$850

Looking to take up a new sport? Try stand-up paddleboarding on the Jimmy Styks Big Bro. The nearly 12-foot-long board is made of EPS foam and fiberglass epoxy, and at over 2 feet wide, it's very stable—the board handles equally well in calm water and medium surf. The price includes everything you need to get out on the water, including fins and a paddle.



UPGRADE

KEEN JACKSON ARMY RUCKSACK \$85

Backpacks are out. Rucksacks are in. Keen's is both spacious and stylish: Its waterproof polyester fabric looks like twill, it has a sleeve for a 15-inch laptop, and its adjustable straps are padded for maximum comfort. Lugging all of your stuff around never looked so good.



WHISPBARS, \$350

Add-on bars for your car roof are nothing new, but only the Whispbar rails, manufactured by Yakima, are this quiet—no annoying whistling here. That's thanks to the winglike shape of the bars, which decreases drag by up to 70 percent. Visit whispbar.com and input your vehicle's information to find the bars that work best for you; each set comes with a custom-fit kit.



EDITOR TESTED



MONTIE PRYOR Y-SHOT SLINGSHOT \$100

Put this in the "whoda thunk it" file: I go to a family picnic with a slingshot and become the life of the party. My nephew declares the Montie "slick." My brother fires it and blurts, "Freakin' scary!" Only a few shots find the target as accuracy becomes secondary to velocity. The thwack of the rubber band and the crack as the ball hits the barn elicit laughter. All this from a gadget cut out of 1/2-inch-thick aluminum plate, with a 16-pound pull weight at a 28-inch draw. Don't let kids use it unsupervised. It's very powerful—charismatic, one might even say. — JOE BARGMANN



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HOW IT WORKS

Propane Outboard Motor

Powerboating is fun for everyone—except the poor sap who mans the motor. It floods, it stinks, and the list of operational steps is longer than Van Halen's tour rider. The propane outboard by **LEHR** (2.5 hp; \$1200) is clean and low-maintenance (no winterizing!), and the fuel has none of the drawbacks of ethanol blends.* Here's what sets the Lehr apart. — ERIN MCCARTHY

UPGRADE

A 1-gallon tank (1) that fits in the motor housing drives the engine for 1 hour to 90 minutes. A larger supply, such as a 20-pound tank (think backyard grill), runs in via an auxiliary port (2) and is good for at least a full day on the water.

Fed through a pressurized line (3), the propane reaches the carburetor (4) as a vapor, making the Lehr less prone to flooding and fouling.

The octane rating of propane is about 110, which provides for a high compression ratio (about 15.5:1, compared with about 14.7:1 in a gasoline outboard). This delivers power more efficiently to the crankshaft.

*Because propane is not a solvent, it doesn't break down an engine's lubricating oils (the way gasoline does), which means greater engine longevity—in theory, at least!

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CHILLSPOT, \$140

Pooches pant to regulate their temperature. But on a sweltering day the hot air they draw in provides no relief. Frozen ChillPods in this insulated bed create a refreshing 24 x 36-inch space. Chillspot was invented by Ken Leahy, who built the first model in his garage; today, the bed is a favorite of the University of Georgia's bulldog mascot, Russ (right), and the pandas at Zoo Atlanta.



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UPGRADE

GEAR UP/Snorkeling

Heading to a tropical beach but no time for scuba lessons? Get your feet wet with snorkeling. Here's your starter kit.

— DALENE ROVENSTINE

1. TRI-EX TRI-EX MASK, \$74

The rigidity of a PVC mask can make it fit poorly and feel like a bucket on your face. Take a step up with the Tri-Ex, which forms a tight but comfy seal, thanks to its silicon fabrication. The field of vision is nice and big too.

2. O'NEILL BASIC SKINS L/S CREW, \$49

Shirts in the water aren't just for scrawny dudes: Covering up with a skin like O'Neill's guards against sun exposure and collisions with reefs or sand. Plus, it dries fast for a seamless transition from the water to the no-shirt-no-service bar.

3. OCEANIC VORTEX V-6 FULL FOOT SPLIT FIN, \$69

Snorkeling enthusiasts prefer fins like these. The full boot secures them to a swimmer's feet, and the split design allows water to flow through the fin for easy kicking.

4. ATOMIC SV2 FLEX SNORKEL, \$60

Excessive water in the snorkel is annoying—and dangerous. The SV2's top keeps out most of the wet stuff, and a valve near the mouthpiece purges any seepage. Breathe easy, friend.

5. OLYMPUS TOUGH TG-320, \$180

During shallow dives snap the tropical fish and coral reefs with this tough 14-megapixel digital camera. Waterproof at up to 10 feet deep and shockproof when dropped a maximum of 5 feet, it features a 3.6x wide-angle zoom lens.

6. RIP CURL MIRAGE FLEX AGGROLITE BOARD SHORTS, \$80

Exploring is fun only if you're comfortable. Fitted at the waist but otherwise roomy, these shorts are made of lightweight stretchy material that moves with you.

SNORKELING TIPS from Capt. Joe Detrick, owner, Fun 2 Dive, Crystal River, Fla. "There should never be pain from water pressure in your ears. To relieve it, pinch your nose and blow. I also recommend the buddy system, even for great swimmers. And make sure you have a dive flag—it will alert boaters that people are in the water."

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Lean and delicious sliders as nutritious as they are portable—the perfect pregame feast. Get the “Two-Bite Burgers” recipe at BeefItsWhatsForDinner.com



BEEF TO THE RESCUE

**THIS SUMMER, MAKE
YOUR (GRILL) MARK
WITH LEAN BEEF**

It's that time again—when a man's thoughts turn to backyards, briquettes and beef. Whether you're cooking for two or a crowd, lean beef's 29 tantalizing cuts have got your summer sizzle covered.

T-BONE

T-BONES WITH SWEET & SAVORY STEAK SAUCE

The T-Bone's namesake bone helps conduct heat within meat for even cooking.

Total Recipe Time: 45 to 50 minutes **Makes** 4 servings

- 2 Beef T-Bone Steaks, cut 1 inch thick (about 16 ounces each)
- Sweet & Savory Steak Sauce (recipe follows)
- 1/2 pound small carrots with tops, trimmed
- 2 tablespoons water
- 2 medium zucchini and/or yellow squash, cut in 1/2-inch slices
- 1 teaspoon olive oil
- 2 teaspoons coarse grind black pepper

1. Prepare Sweet & Savory Steak Sauce. 2. Place carrots and 2 tablespoons water in large nonstick skillet. Cover; cook 8 to 10 minutes or until water has evaporated; add squash. Drizzle with oil; toss to coat evenly. Continue to cook, uncovered, 6 to 8 minutes or until vegetables are crisp-tender and beginning to brown, stirring occasionally. Season with salt, as desired. 3. Meanwhile, press pepper evenly onto beef steaks. Place steaks on grid over medium, ash-covered coals. Grill steaks, covered, 11 to 16 minutes (over medium heat on preheated gas grill, 15 to 19 minutes) for medium-rare (145°F) to medium (160°F) doneness, turning occasionally. 4. Remove bones; carve steaks crosswise into slices. Season steaks with salt, as desired. Serve with sauce and vegetables.

Sweet & Savory Steak Sauce: Combine 1 can (8 ounces) tomato sauce, 1/3 cup chopped pitted dates, 1/4 cup chopped onion, 3 tablespoons balsamic vinegar, 1 tablespoon molasses, 1 tablespoon Worcestershire sauce, 1 teaspoon minced garlic and 1/2 teaspoon salt in small saucepan over medium heat; bring to a boil. Reduce heat; simmer, uncovered, 10 minutes to blend flavors, stirring occasionally. Place sauce in blender or food processor container. Cover; pulse on and off for slightly chunky texture. (For a thinner sauce, stir in additional 1 to 2 teaspoons water.) Return sauce to saucepan; keep warm until ready to serve.

MAN'S SECOND-BEST FRIEND:

Use an instant-read thermometer to penetrate the center of steaks and burgers. Wait 10 to 15 seconds to register the internal temp to ensure safe and savory eats.



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LEAN BEEF

GROUND BEEF

TWO-BITE BURGERS

Whether us guys call them bite-size burgers or "sliders," they're great as appetizers or go-to game-day favorites.

Makes 8 burgers

1 pound **Ground Beef** (96% lean)
9 whole wheat small hamburger or slider buns, split, divided
1/4 cup minced onion
1 egg white, slightly beaten
2 cloves garlic, minced
1/2 teaspoon salt
1/8 teaspoon pepper

Topping Variations:

Mango-Pineapple Salsa or
Spicy Caramelized Onions

1. Tear 1 hamburger bun into pieces. Place in food processor or blender container. Cover; pulse on and off, to form fine crumbs. 2. Combine Ground Beef, 1/2 cup breadcrumbs, onion, egg white, garlic, salt and pepper in medium bowl, mixing lightly but thoroughly. Lightly shape into eight 1/2-inch-thick mini patties. 3. Place patties on grill over medium, ash-covered coals. Grill, covered, 8 to 9 minutes (over medium heat on preheated gas grill, 9 to 10 minutes) until instant-read thermometer inserted horizontally

into center registers 160°F, turning occasionally. About 1-1/2 minutes before burgers are done, place rolls, cut sides down, on grid. Grill until lightly toasted. 4. Serve burgers in buns with Topping(s) Variation(s), as desired. Close sandwiches.

Mango-Pineapple Salsa: Combine 1/2 cup finely diced ripe mango, 1/3 cup finely chopped fresh pineapple, 1/4 cup finely chopped tomato, 1 to 2 tablespoons finely chopped jalapeño pepper, 1 tablespoon finely chopped fresh mint, 1 tablespoon fresh lime juice and 1/4 teaspoon salt in small bowl. Refrigerate until ready to use. *Makes 1 cup.*

Spicy Caramelized Onions: Heat 1 tablespoon olive oil in large nonslick skillet over medium heat until hot. Add 3 cups thinly sliced yellow onions and 2 to 3 medium thinly sliced red or green jalapeño peppers. Cook 5 minutes, stirring occasionally. Reduce heat to medium-low; stir in 1/2 teaspoon cumin. Cook 15 to 18 minutes or until onions are very tender and golden brown, stirring frequently. Season with salt, as desired. *Makes 1-1/2 cups.*

FLIP FOR IT.

Flip steaks with long-handled tongs and burgers with spatulas—you'll lose flavorful juices if piercing with a fork. And resist pressing down on burgers—it just releases the juices and creates hot flare-ups.



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LEAN BEEF

TOP SIRLOIN SIZZLING SIRLOIN KABOBS ON A BED OF ORZO

You gotta love a Sirloin. Ounce for ounce, one of the tastiest cuts of all time.

Total Recipe Time: 35 to 40 minutes **Makes** 4 servings

1 pound **Beef Top Sirloin Steak**, cut 1 inch thick
 2 green, red and/or yellow bell peppers, cut into 1-inch pieces
 1 tablespoon chopped fresh basil or 1 teaspoon dried basil
 1 tablespoon prepared Italian dressing
 2 large cloves garlic, minced
 Salt and pepper

Orzo:

1 cup uncooked orzo pasta, cooked according to package directions
 2 to 3 tablespoons chopped fresh basil or parsley
 2 tablespoons shredded parmesan cheese
 2 teaspoons olive oil

1. Soak eight 8-inch bamboo skewers in water 10 minutes; drain.
 2. Cut beef steak into 1-1/4-inch pieces. Toss beef and bell peppers with 1 tablespoon basil, dressing and garlic in large bowl. Alternately thread beef and peppers onto skewers. 3. Toss Orzo ingredients in medium bowl; keep warm. 4. Place kabobs on grid over medium, ash-covered coals. Grill, covered, about 8 to 10 minutes (over medium heat on preheated gas grill, 9 to 11 minutes) for medium rare (145°F) to medium (160°F) doneness, turning occasionally. Season with salt and pepper, as desired. Serve with orzo.

KABOB BASICS:

When threading cubed steak onto skewers, leave small spaces between. Too loose (or tight) spacing causes uneven cooking.



BRISKET**WASABI-BEER-BRAISED BRISKET**

Brisket's fall-apart-with-the-touch-of-a-fork tenderness makes it a crowd-pleasing cut you can count on.

Total Recipe Time: 4 to 4-1/4 hours
Makes 10 to 12 servings

- 1 boneless **Beef Brisket**, flat cut (4 to 4-1/2 pounds)
- 2 cloves garlic, minced
- 1 tablespoon peanut or vegetable oil
- 1 teaspoon salt
- 1/2 teaspoon pepper
- 2 medium onions, each cut into 12 wedges
- 1 bottle (12 ounces) beer
- 1 bottle (12 ounces) chili sauce
- 2 teaspoons wasabi paste
- Coleslaw (recipe follows)
- 3 whole wheat baguettes, cut into 10 to 12 pieces (4-1/2 to 5 inches each), split

1. Preheat oven to 325°F. Press garlic evenly onto all surfaces of Beef Brisket. Heat oil in large skillet over medium heat until hot. Place brisket in skillet; brown evenly. Remove brisket from skillet; season with salt and pepper. 2. Add onions to large stockpot or large baking pan. Place brisket over onions. Stir in beer and chili sauce; bring to a boil. Reduce heat; cover tightly. Continue cooking in 325°F oven 3-1/2 to 4 hours or until beef is fork-tender. 3. Meanwhile, prepare coleslaw. 4. Remove brisket; keep warm. Skim fat from cooking liquid; bring to boil. Reduce heat and simmer, uncovered, 5 minutes. Stir in wasabi paste. 5. Carve brisket diagonally across the grain into thin slices. Return beef to cooking liquid; keep warm. Divide beef and onions evenly over bread halves; close sandwiches. Serve remaining sauce for dipping, if desired. Serve with coleslaw.

Coleslaw: Combine 1/2 cup rice vinegar, 2 tablespoons peanut or vegetable oil, 2 tablespoons toasted sesame oil, 2 teaspoons minced fresh ginger and 2 teaspoons honey in large bowl. Add 1 package (16 ounces) coleslaw mix and 1 package (8 ounces) shredded red cabbage; toss to coat. Season with salt, if desired.

FLAVOR TIP:

Salt beef after cooking—it draws moisture and juices out of the meat if done before.



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3

Auto

TEST DRIVES

TOP TECH

HOT RIDES

INTEL

BASE PRICE ▷ \$54,200

POWERTRAIN ▷ 662
hp, 631 lb-ft; 5.8-liter
supercharged V-8;
six-speed manual, RWDSUSPENSION (F/R) ▷
Independent strut/
multilink, coil springs

WHEELBASE (IN.) ▷ 112.3

LENGTH (IN.) ▷ 188

WEIGHT (POUNDS) ▷ 4088

BRAKES (F/R) ▷ 14.6-in.
disc/14.4-in. disc; ABS,
ESCTIRES (F/R) ▷ P285/35ZR20;
P305/35ZR20

0-60 MPH (SEC) ▷ 3.7

EPA FUEL ECONOMY
(CITY/HWY) ▷ 15/24

TEST DRIVE

2013
Ford
Mustang
Shelby
GT500

DOWN THE ROAD

AUGUST

EVERY DROP

A hypermiling Aussie couple recently set the world record for miles traveled on one tank of diesel—and it's a lot. **PAGE 38**

LISTEN UP

VW's Soundaktor is a device that electrically enhances engine noise; some owners feel duped. **PAGE 43**

A PERFECT TEMPLATE FOR MANAGING 662 HP—ON THE TRACK, ON THE ROAD, AND AT THE PUMP.

Carroll Shelby, 89, died just days before we drove the 2013 Ford Mustang Shelby GT500. But Ford made sure journalists knew how involved he was with the car, showing video interviews of

REVIEWS

BMW 640i
Gran CoupéPorsche
BoxsterCadillac
XTSNissan Altima
Acura RDX
Lexus ES

Shelby at the Mustang's shake-down at Sebring International Raceway last October. The car sure looks and feels like a Shelby: 662 hp from the bored-out 5.8-liter supercharged V-8; a means-business stance on the outside; a plain-Jane interior ("Give me good seats and a steering wheel, and piss on the rest," Shelby once said); and what Ford claims is a tested 202-mph top speed. Given the base price of \$54,200, including shipping, Shelby would say Ford is leaving money on the table, and he'd be right.

We tested the GT500 at Road Atlanta and at Atlanta Dragway, and the car is equally at home at either. Ford added a slow-down chicane on the Road Atlanta main straight, but we still achieved an undramatic 130 mph. The 20-inch Goodyear Eagle F1 Supercar G-2 radials are excellent, and the Brembo brakes just don't give up. At the dragstrip, Ford claims a quarter-mile time of under 12 seconds, but the best we could manage on a slick track was 12.2 at 121 mph, even using the electronic launch control. Perhaps the biggest surprise, though, is what a driver-friendly car this is, even in stop-and-go commuting. It's a completely livable day-to-day drive, and its fuel economy is high enough to avoid the federal Gas Guzzler Tax. The 2013 GT500 is a bases-clearing grand slam for Ford.

— STEVEN COLE SMITH



Wanted

NISSAN JUKE-R

THE STATS

\$587,340 (est.)

545 hp, 483 lb.-ft.;
3.8-liter twin-turbo
V-6; six-speed, dual-
clutch automated
manual, AWD

Control-arm with
coil springs

15.4-in. front and
15.0-in. rear discs

0-60 mph: 3.3 sec

The Juke-R began as half mad science experiment, half promotion. Nissan originally produced only two of these monsters, and it did so by chopping up a pair of 2010 GT-R supercoupes and appropriating their V-6 twin-turbo motors and all-wheel-drive powertrains. The team fabricated a new floor and fire-wall and new mounting points for the GT-R's control-arm suspension and steering rig. Then they cloaked it all in an even funkier matte-black version of the Juke's sheet metal. Room inside is limited, thanks to a full roll cage and other modifications, but who cares? This is a mini-crossover supercar—three words that don't make sense together yet still promise fun. The version we drove topped out at 160 mph, but the R slips through corners like a lathery bar of soap. Now, thanks to a few interested buyers, there will be a limited run of build-to-order models based on the 2012 GT-R's guts. Sure, the estimated price tag is laughable, but the Juke-R's sheer audacity demands respect. —ANDREW DEL COLLE



Carroll Shelby 1923-2011

CARROLL SHELBY WASN'T an engineer. He didn't go to college. Which might explain why the plainspoken Shelby didn't like fussy explanations when a simple one would do: "Put a big, powerful engine in a little car. That's where you start."

Shelby deployed that recipe to great success when his team took the Ford GT40 to Le Mans to stay Ferraris in the late 1960s, and he used the same plan on dozens of production cars from muscle-era Mustangs

to the first Dodge Viper—even a Dodge Omni got the magic Shelby makeover. And though Shelby lent his name to countless projects, Ford benefited most from the association, which stretched from early '60s AC Cobras all the way to the 2013 Mustang GT500. And his "small car, big motor" formula for success nearly always worked. It's a legacy performance-minded carmakers would do well to heed long after his passing.

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TEST DRIVES

2013 BMW 640i Gran Coupé

BASE PRICE:
\$76,895
MPG (CITY/HWY):
20/30

As automotive architecture, the new 2013 BMW 640i Gran Coupé is one of the all-time-great BMWs. Riding on a 4-inch-longer wheelbase than that of the two-door 6 Series, the Gran Coupé sacrifices a bit of utility compared with conventional four-door sedans in exchange for some spectacular style. Of course, it drives like a BMW, too, sharing most of its mechanical components with the 5 Series, including the 315-hp

direct-injection twin-turbocharged 3.0-liter straight-six engine and eight-speed automated transmission. It can be a dull ride when all the nanny tech is left on, but shut down that overkill and it becomes an entertaining driving companion. The Gran Coupé isn't for everyone, but if it's grandeur you're looking for (and you happen to have a fat wallet), the Gran Coupé may be irresistible. — JOHN PEARLEY HUFFMAN



BASE PRICE:
\$22,280
MPG (CITY/HWY):
27/35

2013 Nissan Altima

For more than a decade the Nissan Altima has won fans by being the rock-and-roll star in a midsize-sedan segment dominated by adult-contemporary rides. And its formula works. In 2011, the Altima was the second-best-selling midsize in the U.S., so it's no surprise that beneath a more styled skin, the 2013 Altima retains the same platform. Overall, though, it's 80 pounds lighter due to a completely redesigned rear multilink suspension for improved handling. It makes a difference: There's loads of grip, the electrically assisted steering doesn't feel artificial, and both the peppy 182-hp 2.5-liter four and the 270-hp 3.5-liter V-6 lead their classes in performance. With either engine, the Altima's a very quiet sedan—as long as you're not deep into the throttle—and a plush cabin is standard, with the softest materials in the most important places, such as the center console. There's also upscale tech borrowed from Nissan's Infiniti brand—minus the sticker shock. Bluetooth comes with, and a navigation system costs just \$590 extra. That's a great deal. — BEN STEWART

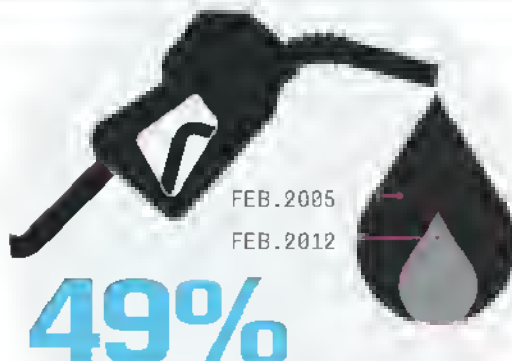
AUTO INTEL

WHEELHOUSE
AUTO ODDS AND ENDS

MANUMATIC MANIA

Have automakers gone overboard naming systems that allow manual control of automatic transmissions? Combine a word from row A with one from row B to get one of these names or possibly create your own. Just be sure to copyright it.

A	Tip	Tap	Sport	Select
	Active	Step	Touch	
B	Matic	Shift	Select	
	Tronic	Stick		



Decrease in American gasoline consumption from February 2005 to February 2012. Although slumps are common in recessions, the numbers plummeted in October. And no one can adequately explain it.

238

Number of facial data points Toyota's experimental mood-recognition system processes. The system gauges if the driver is sad, happy, angry, or neutral and issues warnings accordingly.

1626

New world record for the most miles traveled on a tank of diesel fuel. An Australian couple drove a six-speed manual 2012 VW Passat TDI SE Clean Diesel through nine U.S. states, getting 84.2 miles per gallon out of a 19.3-gallon tank. Not bad.

“There is actually a regulatory doughnut hole.”

DAVID STRICKLAND, NHTSA administrator, on the agency's ability to federally regulate in-vehicle cellphone use. NHTSA can only control a car's hardware, connecting software, and vehicle apps. The FCC's hands are also tied. For now, it's on the states.



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BASE PRICE:
\$49,500
MPG (CITY/
HWY):
20-21/28-30

2013 Porsche Boxster

Porsche has performed only one major update on the entry-level Boxster since it was introduced as a 1997 model, so it was past time for a complete makeover, and we get one for the 2013 model year. Styling remains unique but retains a nice sense of family with the Cayman (which takes a hiatus in 2013, to return a year later) and the 911. Engines in the base Boxster and the S trim get horsepower boosts: a 10-hp bump to 265 hp in the 2.7-liter, and a 5-hp gain, to 315 hp, in the 3.4, respectively. Transmissions are a six-speed manual and a seven-speed dual-clutch automatic called PDK. We tested the Boxster S with PDK at and around Barber Motorsports Park in Alabama, but the car is equally accomplished on the autocross course and on backwoods winding roads. The ride is exceptionally smooth and quiet, the power soft-top is very well-insulated, and the new electric-boosted steering feel is fine, if not as visceral as a purely mechanical system. If you choose your options carefully (this car can get expensive in a hurry), the 2013 Boxster is a versatile, super-satisfying sports car with few peers.

— STEVEN COLE SMITH

TEST DRIVES



BASE PRICE:
\$34,320 (FWD)
\$35,720 (AWD)
MPG (CITY/HWY):
19-26/27-28

2013 Acura RDX

What's new: All the hard-edged sportiness of the Gen 1 RDX has been boiled away, with smooth V-6 power rather than a spirited turbo four—but there's also 33 more horsepower.

Not to worry: Belts are a drag on fuel efficiency, so Acura engineers developed an automatic alternator-belt decoupler that reduces tension up to 30 percent to save gas.

Driving character: If you loved the sporty personality of the old RDX, you won't love this one's softer ride, which is pleasant, comfortable, competent, and as memorable as a bowl of oatmeal.

Problems: The RDX's electric steering system may save gas, but there's more steering effort at speed and less info about tire grip.

Alternatives: Audi Q5, BMW X3, Cadillac SRX, Lexus RX 350, Volvo XC60, Mercedes-Benz GLK.

AUTO INTEL



GLOSSARY

PORSCHE DOOPPELKUPPLUNG [POK]: Also called Dual Clutch Transmission (DCT), a type of transmission where two separate clutches and two separate sets of gears (1-3-5 and 2-4-6) act together for instantaneous, smooth shifts while improving overall efficiency. The system predicts upshifts and downshifts using an algorithm based on factors such as engine rpm, car speed, and throttle application.

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Forget sleek and subtle, the Stauer Colossus Hybrid is one tough timepiece...now for less than \$50!

Never underestimate your competition. Just ask Demetrius, the unfortunate Greek general who set out to conquer Rhodes in 305 BC. He assumed that a massive force of 40,000 men, a fleet of Aegean pirates and an arsenal of wall-smashing war machines would be enough to crush the tiny Greek island. He was wrong. The Rhodians were tougher than he thought. And so is this watch. If you've always believed that the biggest, baddest watches had to cost big, bad money, the \$49 Stauer *Colossus Hybrid Chronograph* is here to change your mind.

A monument to toughness. The people of Rhodes were ready for Demetrius and repelled his attack. To celebrate, they built the Colossus of Rhodes, a 107-foot bronze and iron giant that towered over the harbor like a ten-story trophy. It warned future invaders that "Rhodes is tougher than you think." You give the same message when you wear the Stauer *Colossus*.

The timepiece that works twice as hard. In designing the *Colossus Hybrid Chronograph*, our instructions to the watchmaker were clear: build it as tough as a battleship and fill it full of surprises. Make it a hybrid, because it should work twice as hard as a regular watch. And make it look like a million bucks, because when you put it on, you should get excited about rolling up your sleeves. Mission accomplished.

A toolbox on your wrist. It will keep you on schedule, but the *Colossus Hybrid* is about much more than time. The imposing case features a rotating gunmetal bezel that frames the silver, black and yellow face. You'll find a battalion of digital displays on the dial arranged behind a pair of luminescent hands and a bold yellow second hand. Powered by a precise

quartz movement, the watch is doubly accurate in analog and digital mode. And it's packed with plenty of handy extras including a bright green EL back-light for enhanced nighttime visibility, a tachymeter along the outer dial and a full complement of alarms and split-second countdown timers. The *Colossus Hybrid* secures with a folded steel bracelet that highlights a row of striking dark center links. It's a rugged watch that's more than ready for your daily grind.

Your Satisfaction is Guaranteed. Wear the Stauer *Colossus Hybrid* for 30 days and if you are not 100% thrilled with your purchase, return it for a full refund of your purchase price. But once you get a taste of more watch for less money, it's likely you'll be back for more... and we'll be waiting.

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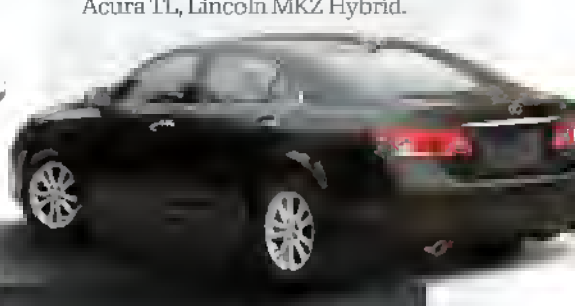
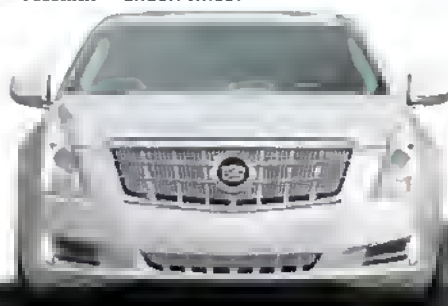
2013
Cadillac XTS

The XTS is Cadillac's first all-new vehicle in three years and didn't arrive a moment too soon. It marks the beginning of a lineup refresh that will include the ATS, CTS, and eventually the Escalade. The future of the XTS is bright, thanks in part to fresh styling and a genuinely luxe interior that includes leather in the base model and a lengthy list of standard items that only gets lengthier as you approach the top-tier Platinum version. Cadillac's new Cue multimedia interface offers an intuitive touchscreen-based system with haptic feedback and a voice-recognition system. Novel techie options include a Safety Alert Seat that vibrates either one or both sides of the driver's seat bolsters if the lane-departure and distance-sensing systems detect trouble. The XTS managed the spaghetti-like roads of Malibu Canyon with surprising ease considering its 2 tons of avoirdupois, but its mellow V-6 makes us eagerly anticipate the inevitable hot-rodded V version. — BASEN WASEF

BASE PRICE:
\$44,995
MPG (CITY/HWY):
17/27-28

BASE PRICE:
\$36,000 TO \$43,000
MPG (CITY/HWY):
21/31 (ES 350),
24/31 (ES 300H)

AUTO INTEL

2013 Lexus ES
350 & 300h

What's new: An upgraded interior and more back-seat room, as well as slicker styling and better handling, increase its class competitiveness.

Neat trick: The Mark Levinson audio system uses powerful magnets to reduce weight in the speaker system—contributing to better fuel economy.

Driving character: The ES still leans toward luxury, not sports-sedan prowess, but unlike the 2012, this one's confident when cornered.

Roadblock: Although Audi and BMW continue to get younger buyers, Lexus's ES loyalist is older and likely doesn't want the car to get too sporty, which puts the brand in a tough spot.

Alternatives: Audi A6, Cadillac CTS, Acura TL, Lincoln MKZ Hybrid.

THE LOT

Acura TSX

Price Range \$10,000 to \$17,500



Handsomely understated, with plenty of luxury features.

Why It's Cool

Lively and luxurious, the original TSX has rightly been coined a Japanese BMW 3 Series because it had the same uncanny combination of supple ride, sharp handling, and fluid manners. But just as driving enthusiasts started to take notice, Acura replaced it with the heavier, larger—and far less fetching—second-gen TSX.

What It Says

I don't need a European badge to recognize a true driver's car.

Watch Out For

Power-steering hoses have a tendency to crack and spray fluid onto the engine. Can you say "fire hazard"? Honda issued a recall, but make sure the work has been done. Aside from that, it's bulletproof.

Why You Want It Anyway

Thousands cheaper than a comparable Euro sedan, and it's got front-wheel drive, so it's better in the slippery stuff. Find one with the six-speed manual and you'll gain instant cred among driving cognoscenti.

PM FLEET

CARS WE LIVE WITH

2012 FORD EDGE

FIRST REPORT

Three decades ago, a family hauler would have had a V-8. Now we've got a 4000-pound Ford Edge crossover with a comparative peashooter—a 2.0-liter four-cylinder. But this minmotor is from Ford's EcoBoost family, so it's turbocharged and produces more horsepower (240) and more torque (270) than the V-8 in a 1982 Ford Crown Vic. Still, would there be

enough grunt to merge onto an upstate New York parkway with a swarm of speedy drivers? That's a yes. The point of this engine is better fuel economy, and though it's not the 24 mpg on the sticker, we're averaging 20.8 mpg after 2713 miles. The Edge also talks. "Please say a commend," it says, then dials the phone, sets the radio or temp, or provides directions. This is the upgraded MyFord Touch infotainment system, which addresses complaints that dogged the original. It starts up quicker, processes requests faster, and is less prone to crashing. The nav system is one of the best we've seen, and the graphics are clear. There are moments when the car seems hard of hearing, but so far, we're hopeful about the relationship. — **MICHAEL S. CAIN**



DRIVERS NOTEBOOK

- The Touch system mic is positioned overhead and is partially blocked by the driver's sunshade—not ideal. You learn to aim your voice upward.
- Passengers praised the comfort of the interior, but taller drivers may find they need to dramatically bow their heads when climbing into the cockpit.

VITAL STATISTICS

BASE PRICE/AS TESTED
 ▶ \$31,060/\$35,845 (not including destination charges)

EXTRA-COST OPTIONS
 ▶ MyFord Touch, Leather Comfort package, rearview camera, ambient lighting, voice-activated navigation system, 2.0-liter GTDI EcoBoost engine, blind-spot monitoring

POWERTRAIN ▶ 240 hp, 270 lb.-ft; 2.0-liter turbo I-4; FWD

EPA FUEL ECONOMY (CITY/HWY) ▶ 21/30

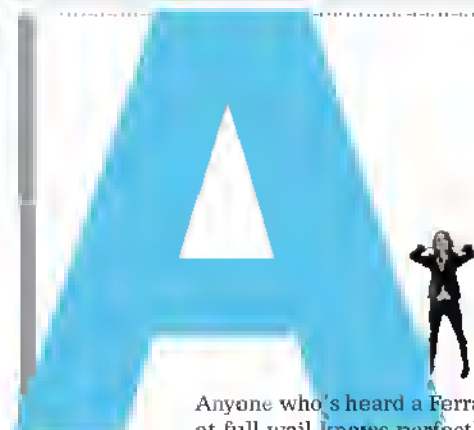
MILES DRIVEN ▶ 2713

PM FUEL ECONOMY ▶
 Average: 20.8 mpg
 Best: 25.8 mpg
 Worst: 18.0 mpg

MAKING NOISE

TO MAKE ENGINES SOUND BETTER, SOME AUTOMAKERS ARE BROADCASTING MOTOR NOISE THROUGH SPEAKERS. IS THIS PROGRESS, OR HAS A LINE BEEN CROSSED?

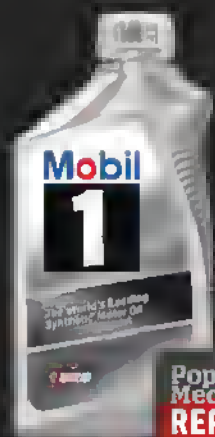
BY LARRY WEBSTER



Anyone who's heard a Ferrari V-8 at full wail knows perfectly well that engines make music. But today, that *vroom-vroom* is getting harder to hear, thanks in equal parts to turbochargers that muffle the noise, increasingly insulating cabins, and government noise regulations.

Automakers are well aware that a snarly engine note enhances the behind-the-wheel experience—especially for sporty cars—and all sorts of devices have been used to let in this “good” noise. The Corvette's exhaust system has a valve that opens under full throttle and bypasses the muffler. The Porsche Cayman and the Ford Mustang both have “noise pipes” that connect the intake system to the cabin. These passive systems, however, are slowly being replaced with active systems that play a pre-recorded track through speakers.

Case in point: VW's GTI used to have a noise pipe, but when the



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PHOTOGRAPH BY SAM KAPLAN



latest version appeared in 2011, the pipe was replaced with the Soundaktor. This system uses a hockey-puck-size speaker mounted on the firewall to generate extra noise. VW didn't exactly advertise the feature, and when word got out, the forums lit up.

"The Soundaktor is only there to lie to me," fumed one GTI owner on vwvortex.com when he found out his car has the system. "It's false advertising, plain and simple."

Andrew Wong is a 29-year-old engineer from Detroit. When he learned that his 2011 GTI had the Soundaktor, he simply removed it. Now he relies on an aftermarket exhaust system for better noise. "I want to hear the engine, rather than some version of the engine being played to me," he says.

VW is not alone. The new BMW M5, which ditched the sonorous V-10 for a twin-turbo V-8, plays an engine soundtrack through the car's audio system. From a carmaker's perspective, these active sound generators have definite benefits over a sound pipe: There's no need to cut a hole in the firewall or package a separate tube in the already crowded engine bay. Plus, the active devices allow a far greater degree of tunability and can be used to mask unwanted noise.

It remains to be seen just how far automakers will take these systems, but in the future, you may be able to toggle a switch that makes your Prius howl like it's got a V-8. **PopMech**

VW MOUNTS
THE ABOVE
SPEAKER
ON THE
FIREWALL
OF SPORTY
MODELS LIKE
THE GOLF R
TO ENHANCE
ENGINE
SOUNDS.

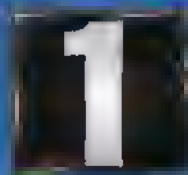


AUTO INTEL



GLOSSARY

TREAD SQUIRM: A term for describing the wiggle that occurs in a tire's tread block while the vehicle is in motion. Most common in new tires, which have fresh treads, and in snow tires, which have deep tread blocks. Tread squirm decreases as the tread blocks get some wear.



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Precision German engineering is revered in automotive-performance circles worldwide. One fact most motoring enthusiasts might not know: Porsche engineers are able to rev their engines higher thanks to Mobil 1 technology.

Because Mobil 1 synthetic motor oil is formulated to withstand oxidation at temperatures exceeding 500 degrees Fahrenheit, Porsche can design engine components to endure rotational forces that exceed conventional oil capacities. Porsche mandates that all of its race engines run failure-free for at least 30 hours. The oil has to withstand this test without degrading - In engines that turn at extremely high revs.

Racetrack feedback has helped ExxonMobil and Porsche test their respective products since 1996, the year the partnership formed for the Porsche Supercup Series. Today this is known as the Porsche Mobil 1 Supercup Series, a prestigious racing event that holds a high honor among Porsche and racing enthusiasts around the world.

The verdict: Mobil 1 motor oil is the factory fill of all Porsche engines worldwide. As Porsche owners know, it's tough to top what the factory does. The partnership between Mobil 1 and Porsche demonstrates high-performance engineering at its most highly refined level.



JAY
LENO'S
GARAGE

Long Live Saab!

THE ORIGINAL BRAND MAY BE GONE, BUT I'LL ALWAYS ADMIRE ITS INNOVATIVE APPROACH. BY JAY LENO

Somewhere over in Sweden there's a Dumpster full of Saab letterhead, employee ID badges, and day planners. There are guys going through what once were Saab's offices, hanging auction tags on the furniture, computers, printers, and water coolers.

The winged logo on Jay's 1958 93B references Saab's aviation origins.



Saab went bankrupt in December 2011; in June, a company called National Electric Vehicle Sweden AN (NEVS) announced it would buy the marque, reportedly to make electric vehicles bearing the venerable name. NEVS is owned 51/49 by Chinese and Japanese interests, respectively, and China is the initial target market for the next generation of Saabs. But the Saab I knew and loved is gone, and I miss it.

When I was a kid, Saabs were unique. I first rode in one while I was in high school. A friend's mother had an old model with a two-stroke engine and a differential incorporating a freewheel hub system like the one on a 10-speed bicycle. It didn't go fast, but when my friend's mom took her foot off the accelerator pedal, there was no compression braking. The car just kept rolling along. I was fascinated.

Saabs were front-drivers when every American car had rear drive. Their two-stroke, three-cylinder engines sounded like popcorn machines—poppoppoppaawwwup!—while other cars were muffled into silence. The first Saab car, the 1950 model 92, was built around an aerodynamically slick unihody. It rode on an all-independent torsion bar suspension and used something called rack-and-pinion steering. It was impossible to over-rev a Saab's engine because it ran



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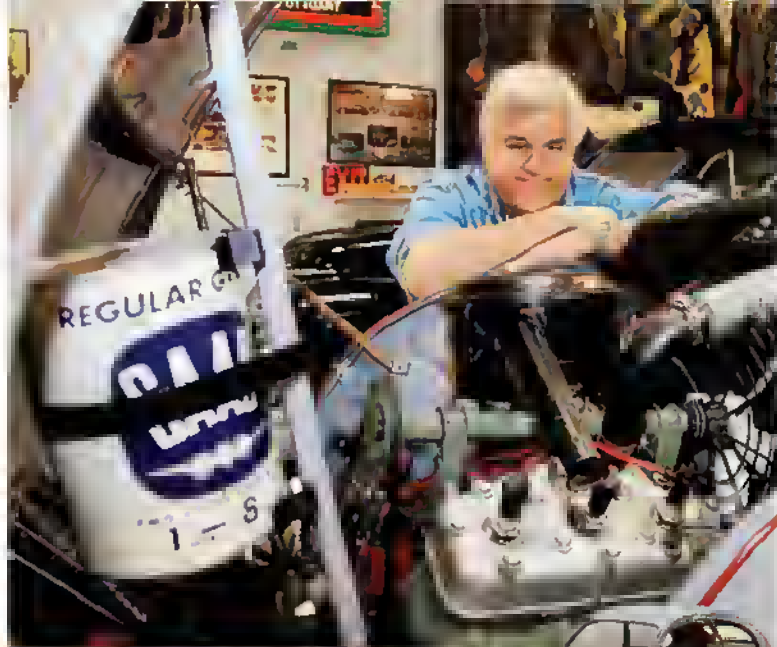
From rims to roof, Black Magic® has a product to bring out the shine in any car, and the Carcissist™ in anyone. Just remember to drive slowly so people have enough time to stare.

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Available at **Walmart** 
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Above: A handy bracket holds a spare can of two-stroke oil. Right: Saab was an early pioneer of aerodynamic bodies.



out of power before the redline. So you just threw your boot at the gas pedal and shifted up until there was evidence of forward momentum. All that unconventional engineering led to good fuel economy: Saabs got better than 25 mpg.

In the '50s and '60s, owning a Saab meant more than having an odd car in your garage; it was a lifestyle choice. With that two-stroke engine, you had to premix your gas and oil. So you trudged to the gas station with two 5-gallon cans, filled them up most of the way with gasoline, and then topped them off with oil at a 50:1 ratio. After a shaking to mix them up—and remember, gas weighs more than 6 pounds a gallon—you could fill the Saab's fuel tank. But there was never any oil sump to drain and virtually no other routine engine maintenance. Under the hood a clamp held an extra quart of premix oil.

On cold mornings, if you wanted to warm up a Saab's engine more quickly, you pulled a chain dangling from the dashboard to lower a "shade" that blocked airflow to the radiator. Naturally, the cabin heater was phenomenal.

My Saab is a 1958 model 93B. It doesn't have the key on the floor like later Saabs, but this was the first year for the one-piece front windshield, and the doors are hinged at the back, suicide style. With a 750-cc engine making about 33 hp, it's not fast. But you can go 70 mph down the road with four people in it. It has cruise control too; just put your foot to the floor and keep it there.

To me, however, my Saab's most fascinating detail is the water pump that's located on the back end of the generator. The Swedes could make it work, but imagine if a British car company had tried this. At best it would have functioned correctly; at worst it would have electrocuted anyone who touched it.

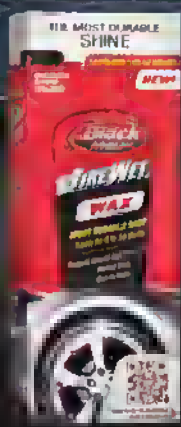
Beyond their engineering idiosyncrasies, though, Saabs were effective. The company was building rigid, light weight, and aerodynamic cars when other manufacturers ignored these considerations in their engineering. A Saab didn't look or drive like anything else on the road, and it attracted buyers to match.

It seemed for a while that every time a professor at a college in New England was awarded tenure, he or she got a Saab to go along with it. Intellectuals, eccentrics, and other free-minded, countercultural types seemed to adopt Saabs almost instinctively. The author Kurt Vonnegut even owned a Saab dealership—Saab Cape Cod—in the late '50s.

When Saab switched to Ford-sourced four-stroke V-4 engines in 1967, the brand lost some of its charm for me. Of course, Saab did some innovative things after that. The 1978 Saab 99 Turbo ushered in a new era of efficiency, and the later 900 Turbo was sophisticated. Then GM bought Saab, intending to turn it into a BMW competitor. Suddenly there were Saabs that were Subarus with new badges or Chevy TrailBlazers with their ignition key on the floor. Without quirkiness, Saab became just another car. **PopMech**



'69 Chevy Camaro Z28
Owner: Leslie Gentry, Actual Carcissist™



Sunset is no excuse to stop shining.

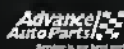
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HOW TO MINE AN ASTEROID

BY MICHAEL BELFIRE

In April a group of aerospace veterans and investors, some of whom are pictured below, announced an audacious venture: a company, Planetary Resources, dedicated to mining asteroids. "Breakthroughs require taking extraordinary risks," says co-chairman Peter Diamandis. The company, backed by technology trailblazers such as Google CEO Larry Page, movie director and inventor James Cameron, and Microsoft software guru Charles Simonyi, does not expect a fast return on investment. "Within a small number of years, we'll be flying to asteroids," says co-chairman Eric Anderson. "But we have a 100-year view for this industry."

THE
400+
ILLUSTRATIONS



Eric Anderson
Space Adventures



Peter Diamandis
X Prize Foundation



Larry Page
Google co-founder



Charles Simonyi
Two-time
space tourist

SPACE MINERS WANT TWO THINGS:

**WATER**

A 23-foot-diameter carbonaceous chondrite (C-type) asteroid can hold 24,000 gallons of water, which could be used to make rocket fuel or replenish spacefarers.

**METALS**

A 79-foot-wide metal (M-type) asteroid could hold 33,000 tons of extractable metals, including \$50 million worth of platinum alone. But can a mining spacecraft cut off treasure from these metal objects?

EROD



STEP 1

GET PROSPECTING

TO MINE AN ASTEROID, A COMPANY like Planetary Resources first has to find one that promises a good return on investment. But asteroids don't glitter like stars. They are small, dark, and easily obscured by the distorting effect of Earth's atmosphere. The best way to hunt for them is with a telescope floating in space. At the Bellevue, Wash., headquarters of Planetary Resources, chief engineer and company president Chris Lewicki is assembling the components of the first privately owned space telescope, the Arkyd 100 series.

The 44-pound spacecraft will be smaller and simpler than any government-funded space tele-

scope. The \$1.5 billion Hubble Space Telescope has a 94-inch-diameter primary mirror; Arkyd's mirrors will be 9 inches wide. Hubble has a wide field of view, as well as other instruments to scan objects in distant space. Arkyd needs only to look in our own solar system for targets. Being small saves money: Rockets carrying larger sats could also haul these telescopes as secondary payloads, decreasing launch costs.

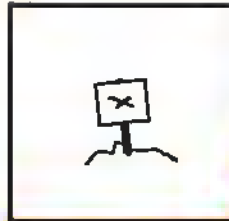
Planetary Resources plans to build a fleet of space telescopes to help drive the per-unit cost down to less than \$10 million. Having multiple telescopes is insurance in case one fails. "We need to make something in an assembly line," says Lewicki, a former Jet Propulsion Laboratory Mars mission manager. "We can't just build one precious jewel that we treat with kid gloves."

The Planetary Resources team will also rent out the Arkyd 100s, the company's first stab at making money. Its space telescopes can be used by cosmic researchers or by Earth scientists who want to examine the planet from space at a resolution of about 6 feet per pixel. Planetary Resources hopes to launch the first satellite by the end of 2013; company officials say rental prices have not yet been determined.

A NASA engineer stands in front of six segments of the James Webb Space Telescope's primary mirror. Space miners may field the first privately owned space telescopes—and rent them out.



STEP 2



A S S A Y A N D
A C C L A I M

ONCE COMPANY TELESCOPES SPOT A MINING prospect, there's only one way to determine what resources the asteroid contains: Get close.

The Planetary Resources team envisions a swarm of prospecting bots heading out to conduct close flybys of near-Earth asteroids (NEAs). "We're talking about building interplanetary probes at a fraction of the cost [of current models], which requires doing things very differently," Diamandis says. NASA has used this form of propulsion twice for deep-space exploration. It uses electricity to positively charge xenon atoms, which are pulled out of the craft by magnets. The repulsive force provides thrust that propels a vessel, building speed over the course of years. It takes a while, but when it gets going the craft can exceed 200,000 mph.

The asteroids of interest likely will be less than 1 mile in diameter, too small to have appreciable gravity. Spacecraft don't land on such small asteroids; they dock to them. A spacecraft will slowly approach, getting close enough to barely touch the asteroid's surface before deploying an anchor. Grappling hooks might just grab a chunk of surface material and float away. A better option is to deploy drills in each landing pad that secure the craft to the surface.

The robot would then analyze the water and metal content of the asteroid and beam the results to Earth. The tool of choice for this assay would be a laser-induced breakdown spectroscopy system, or LIBS. Lasers vaporize surface material so sensors can analyze the light emitted by the resulting plasma →

STEP 3



A prototype robot, created by NASA's Jet Propulsion Laboratory, has 750 steel hooks for feet. These adhere to rough surfaces, preventing bots working in low gravity from drifting away.

START

ONE ASTEROID TO GO, PLEASE

Asteroids could be brought closer to home for study and mining. In an April publication, the Keck Institute for Space Studies, based at Caltech, looked at how to bring one to lunar orbit. Such a rock could provide an attractive destination for astronauts. "The mission will be a stepping stone into the solar system," says study co-leader Louis Friedman.

S T A K E



1. MEASURE IT A slew of laser radar sensors measures the dimensions of the asteroid. A spacecraft then deploys its high-strength capture bag to the appropriate size. Inflatable arms and cinching cables unfurl to enclose the asteroid.

2. BAG IT The spacecraft bags the rock. The finish on the bag's exterior ensures that the asteroid doesn't heat up and lose water.

3. BRING IT HOME The craft makes the long trip back to lunar orbit. The return trip could take six years; mining commences on arrival.

to identify elements. The first LIBS to be deployed to another world, ChemCam, is currently en route to Mars aboard NASA's Curiosity rover.

The prospecting craft might also tag the asteroid by planting a radio beacon on its surface. According to company officials, the beacon would do more than help future missions get a fix on an asteroid's location. "Placing a beacon is part of building a case for ownership," Diamandis says.

A private company's claim to an asteroid is uncharted legal territory. In the next decade lawyers may have to factor in the presence of private-sector entrepreneurs in the Outer Space Treaty, first signed in 1967 and ratified by more than 100 nations. If it turns out that possession really is nine-tenths of the law, then a simple radio transmitter could help make the miner's case.



DIGGING

SPACE MINERS WILL PRIZE WATER MORE than gold. Its value manifests when it is split into its elements: Hydrogen can recharge power cells and be recombined with oxygen to produce energy-rich fuel. Harvesting water in space is cheaper than shipping it from Earth. Every gallon, at a weight of 8.33 pounds, can cost tens of thousands of dollars to launch. Planetary Resources could profit by selling space-harvested water to governmental or private spacecraft at a premium but for less than it would cost to deliver from Earth.

Carbonaceous chondrite asteroids are the best prospects for water. The surface of these so-called C-type asteroids is crumbly, says John Lewis, professor emeritus at the University

ASTEROID MINING INFRASTRUCTURE

ORBITAL TRANSPORTATION HUB

A larger, manned space station is an ideal place to coordinate flights of cargo, mining gear, and explorers.

SPACE FUEL DEPOT

Spacefarers will need places to restock water and hydrogen for fuel (think space gas stations). Scientists today are working on ways to transfer fluids in zero-g.

DEEP-SPACE COMMUNICATION RELAY

Optical laser communications can transmit as much data as radios and use half the power. Planetary Resources is developing a system under contract with NASA.

of Arizona and author of *Mining the Sky*, the seminal book on the space industry. "You can hold a cube between your thumb and your forefinger and crush it," he says. There's no need to burrow; you can just scrape the surface of a C-type asteroid to mine its water.

A swarm of mining bots, clinging with barbed feet to the surface of an asteroid, would slurp up water-laden soil through proboscis-like drills, while others would vacuum the debris left in their wakes. The robot would then pull out the soil, or regolith, and deposit it in a sealed container. The robot would walk, float, or crawl to a processor lashed to the surface or

floating above it. The processor would heat the regolith to release water vapor, which would be collected into a storage tank.

Space miners face a more difficult challenge when harvesting metal. M-type asteroids, essentially big flying chunks of solid metal, might not feasibly be mined, says Harry McSweeney, geoscientist at the University of Tennessee and chair of the surface composition group for NASA's Dawn asteroid probe. Anchoring to such a body would be hard enough—drill-style landing pads wouldn't work—let alone sawing off a chunk of the asteroid for processing. "When you think about how much energy would be

required, it seems pretty unrealistic," McSweeney says.

But Lewis figures that some asteroids might be made up of as much as 30 percent metal, in the form of an iron-nickel-cobalt and platinum-group alloy. "The temptation is to simply use a magnet to pluck the metal grains out of that regolith," he says.

Some metal-rich asteroids might be worth taking closer to Earth, as close as the moon, in their entirety. "The concentration of metal is so high that you have to wonder whether you could just bring the whole thing back," Lewis says. (It's not so far-fetched; see "One Asteroid to Go, Please" page 53.)

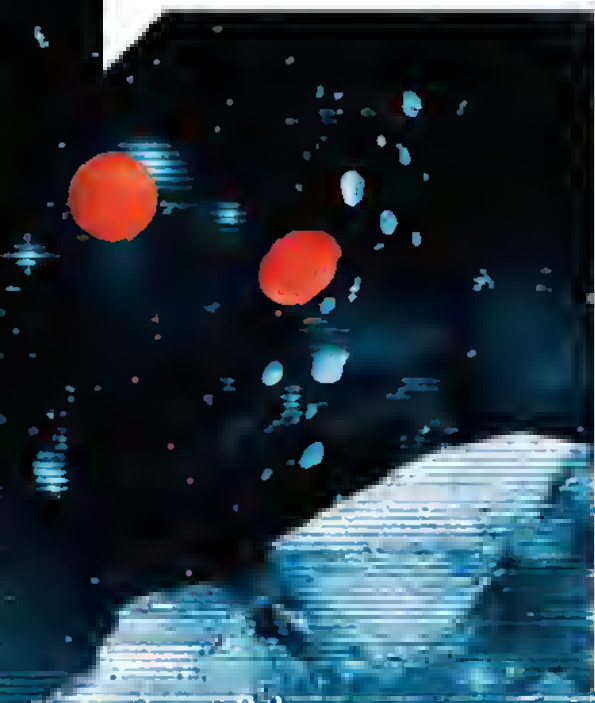
OUR RICH SOLAR SYSTEM

Between 2009 and 2011, a NASA space telescope called the Wide-field Infrared Survey Explorer (WISE) cataloged asteroids in our solar system. It found:

More than 100,000 previously unknown asteroids in the belt between Mars and Jupiter.

19,500 midsize near-Earth asteroids.

4700 large, potentially hazardous asteroids that cross within a cosmically close 5 million miles of Earth's path. (NASA estimates that it has cataloged only 30 percent of them.)



SPACE MINING TECH



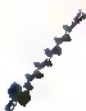
MAGNETIC RAKE

There is no need to dig mines to gather precious metals from space rocks. By placing a magnet on each prong of the rake, loose regolith (asteroid soil) can be combed easily for precious metals in low gravity.



LOW-GRAVITY SIFTERS

Old-school gold miners rejoice. In 2009 scientists used a vibration table to shake soil through a sieve to separate the particles that would burn most efficiently in an oven; heated asteroidal material releases oxygen. The system worked in zero-g, simulated by parabolic flights of an airplane.



ASTEROID ANCHORS

With almost no gravity, asteroids won't be easy to land on, let alone allow for operating drills and other mining equipment. NASA's Jet Propulsion Laboratory is developing steel "toenails"; Honeybee Robotics is creating screw-in augers to keep space machinery from floating away.

DELIVER THE GOODS



SPACE SELLS, BUT WHO'S BUYING?

It remains unclear who will purchase the goods that space miners have gone to such pains to gather.

The most lucrative opportunity might be platinum-group metals—one category of the few space commodities that would be shipped back to Earth. "These materials enable so many different high-tech processes that we use," Lewicki says. Today, platinum-group metals are essential to catalytic converters in petroleum engines, as catalysts in the production of silicone, and in the manufacturing of glass. They are incorporated into hard drives; in spark plugs, where their low corrosion rates allow 100,000-mile life spans; and in medical devices, where they are prized for their biocompatibility.

A 500-ton asteroid with 0.0015 percent platinum metals—a common percentage—would have three times the richest concentration found on Earth. "To have more of this material will open up economies that we can't even predict," Lewicki says.

But most asteroid commodities will only be marketable in a future where ambitious spaceflight is a regular human activity; for example, extraterrestrial depots where spacefarers could top off their fuel tanks and water supplies while on long trips. If there are no such trips, there is no business model.

Similarly, the idea that common metals will be useful in space is predicated on a manufacturing industry that is building space stations and spacecraft in orbit. Assembling structures in space, rather than launching them from Earth, is appealing because it avoids the cost of launch. A lack of orbital construction or the advent of cheaper launch systems could obviate this business.

If space stations are growing food for full-time residents, they could become lucrative markets for more than iron and steel. Asteroid-derived nitrogen and ammonia would be in demand for fertilizer. Such industries are vital if humans are to make their home in space. "We're talking about technologies that break the umbilical cord to Earth," Lewis says.

Planetary Resources' scheme is more than a business plan, it's a rose-colored blueprint for supporting space exploration. Its existence speaks to humanity's drive to explore, to spread, and to support the most audacious of our dreams. **PopMech**

STEP 4





OLYMPIC SCIENCE

BY JOE LINDSEY
PHOTOGRAPHS BY PEJ BEHDARVAND

WHEN THE ELITE COMPETE THIS SUMMER AT THE GAMES IN LONDON, STATE-OF-THE-ART GEAR COULD MEAN THE DIFFERENCE BETWEEN FINISHING BACK IN THE PACK OR WINNING A PLACE ON THE PODIUM. HERE ARE SOME KEY TECH BREAKTHROUGHS THAT WILL HELP ATHLETES PURSUE THE OLYMPIC IDEALS—SWIFTER, HIGHER, STRONGER.

SWIMMING



MAKING WAVES

Twenty-five Olympic swimming records were broken in Beijing in 2008, 23 of them by athletes wearing Speedo's LZR Racer. But the super-suit, made of a woven nylon-elastane blend with water-repellent polyurethane panels, spawned a major backlash—one coach called it a form of “technological doping.” In the summer of 2009, FINA, the sport’s international governing body, announced new rules for suits: textiles only (no impermeable fabrics) and no full-body coverage for men. Speedo developed a compliant LZR Racer Elite, which some athletes will wear in London, but its U.K.-based Aqualab division also got to work on the Fastskin3 System—a suit designed together with cap and goggles, marking the first time Speedo has invested heavy R&D in those accessories.

STRONG SUIT

The improved hydrodynamics of the Fastskin3 Super Elite suit (above), which reduces drag up to 2.7 percent more than the LZR Racer Elite, is the result of computational fluid-dynamics analysis and water-flume tests to study passive drag (where water flows over a motionless swimmer holding a towline) and active drag (where a swimmer works at race pace). The Fastskin3 fabric—a nylon-Lycra blend—has zoned compression panels of vary-

ing densities—most knit, some woven—that help to hold the body in the most efficient position: hips high, core supported. The men’s suit has a high waist, covering as much area as FINA rules allow. Exterior marker lines help athletes align the suits.

WIDE VIEW

A lot of hydrodynamic drag comes from the head (the leading edge), especially the facial area, so Speedo used 3D head-scanning data to design goggles (opposite) that smooth out facial gaps and holes (with Western and Asian fit variants), cutting hydrodynamic drag 2.2 percent more than its Aquasocket model. A full 180-degree field of vision gives a clear view of the competition, and the lens shape significantly reduces force on the goggles, preventing them from shifting during entry and high-speed turns. Pair the new goggles with the Fastskin3 cap (opposite), whose design emerged from the same head-scanning data, and that 2.2 percent drag savings jumps to 5.7 percent.





EASY-TO-REACH REE

CABLE-TIGHTENING DIAL

ROTOR

ROTOR

ROTOR

VR00MEN.WHYTE.DESIGN

TRIATHLON



RACE
WITH THE
PACK

The grueling triathlon debuted as an Olympic event in 2000. In this year's edition, racers swim 1500 meters in the Serpentine, a lake in London's Hyde Park; switch to bikes for a 43-kilometer ride (3 kilometers longer than in previous Olympics); and finish with a 10-kilometer run—all in less than 2 hours. Speed is paramount not only on the course but also during transitions, which take athletes about 30 seconds and are strictly regulated. After the swim, for example, athletes must put on their helmets before mounting their bikes and can only mount outside the transition area (where gear is stored).



QUICK CHANGE

After athletes finish their swim, they sprint to the transition area to wriggle out of wet-suits and grab bikes prepped with shoes already clipped to the pedals. The Specialized S-Works Trivent shoe (opposite) has a draw-bridge heel that pivots away on a hinge so the rider can simply slide into the shoes—as with a pair of clogs—and cinch up the heel, saving seconds over squeezing into a conventional closed heel. A Boa reel closure system also shaves time: Three turns of the dial wind up the steel-cable lacing and clamp in the heel cup firmly. To get out of the shoe for the running segment, athletes just pop out the rotary dial and lift their feet out.

FAST FORM

An elite triathlete exerts about 300 watts of power during the biking leg, and at 40 kilometers per hour (the typical Olympic pace), cutting 100 grams of aerodynamic drag saves 10 watts, which means athletes can ride faster at the same effort—up to 40 seconds faster over a 40-km course. That's a serious edge

in a race where the first and the last athlete are separated by only 2 or 3 minutes on the biking leg, so bike-makers are constantly innovating to improve aerodynamics. (The rider's body accounts for about 70 percent of drag—the rest is in the gear.)

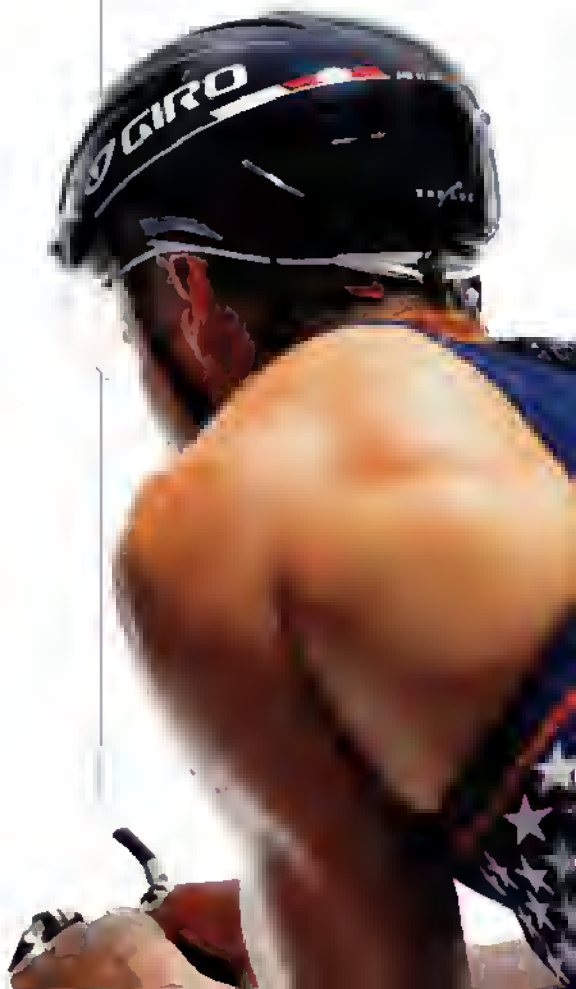
The Olympic tri is a draft-legal race, which means riders can group in packs, reducing the energy required to overcome wind resistance. But aerodynamic gear still plays a key role. Cervelo's S5 (above), created for the demands of road-bike racing, makes a good mount for draft-legal triathlons, which ban most conventional triathlon bikes (like the Cervelo P5, opposite, which some athletes will ride in the time trial event).

Like many aero bikes, the S5 features airfoil-shaped tubes, but Cervelo used extensive wind-tunnel testing to refine how the bike's carbon-fiber-composite frame works with its attendant parts (and rider). The seat stays are shaped to direct air around the rear-brake caliper, normally a source of turbulence. Brake and shift cables are routed internally, which saves 40 grams of drag over externally routed systems. The sum

of Cervelo's innovations: In its tests the S5 saves 6 to 22 watts (depending on what bike it's up against) even when a rider is drafting.

HEAD GAME

The teardrop-shaped helmet favored by most triathletes since the 1990s is more aerodynamic in wind-tunnel tests than a traditional road-bike helmet. But recent research, including sophisticated data-capture trials in real-world conditions, shows that in anything other than a straight-on headwind, the teardrop shape loses its aero advantage. On Giro's Air Attack helmet (below), the frontal area looks much like a traditional road-bike helmet's. The Air Attack mimics the performance of a teardrop helmet in headwinds and is actually more aerodynamic than the teardrop in crosswinds or when a rider turns his head.





TIMING IS EVERYTHING

At the 2008 Beijing games, Michael Phelps needed a win in the 100-meter butterfly to tie Mark Spitz's record of seven gold medals in a single Olympics, set in 1972. In the home stretch it was a dead heat between Phelps and Serbian Milorad Čavić. Čavić appeared to touch the wall first, but Phelps was the first to exert the 6.6 pounds of pressure required to activate the touchpad. The result: a victory margin for Phelps of 0.01 second, which the Serbian team disputed. But a review down to 0.0001 second confirmed Phelps's gold—and he won an eighth the next day as a member of the 400-meter medley relay team. This year official Olympic timekeeper Omega has taken horological precision to a new extreme: Its Quantum Timer measures differences in performance down to one one-millionth of a second. Here's how time has changed in a century-plus of Summer Olympics competition.

DEGREE OF
ACCURACY

0.2 SEC
0.1 SEC
0.001 SEC

1896



Athens
Officials at the first modern Olympics rely on analog stopwatches to determine winners.

1912



Stockholm
Analog stopwatches yield to electronic ones, but finishes are still hand-timed. The margin of error is 0.2 second—almost 2 meters in a typical 100-meter dash.

1932



Los Angeles
In its debut as official Olympic timekeeper, Omega uses 30 precision chronograph stopwatches for each event. Degree of accuracy: 0.1 second.

1948



London
Machines begin to take over. The first Olympic photo-finish camera, dubbed the Magic Eye, revolutionizes sports timekeeping. Degree of accuracy: 0.001 second.

1960



Rome
U.S. swimmer Lance Larson loses gold to Australian John Devitt when officials disagree on Larson's time. It's the last Olympics where disputes are resolved by the human eye.

1968



Mexico City
Timing touchpads are introduced in the Olympic pool. Now the swimmer's own fingers stop the clock with a precision of 0.01 second.

1972



Munich
Swedish swimmer Gunnar Larsson wins gold in the 400-meter medley by 0.002 second. Days later, the sport's governing body rules that times be measured only to 0.01 second.

1984



Los Angeles
Americans Garrie Steinseifer (left) and Nancy Hogshead are the first to share gold in Olympic swimming history for their tie (55.92 seconds) in the 100-meter freestyle.

1996



Atlanta
GPS timekeeping is introduced for the sailing regattas at the coastal city of Savannah to track the speed and location of individual boats.

2012



London
To flag false starts in track and swimming events, starting blocks will monitor pressure exerted by athletes' feet instead of early movement.

LOS ANGELES

ATLANTA

MEXICO CITY

STOCKHOLM

LONDON

MUNICH

ROME

ATHENS



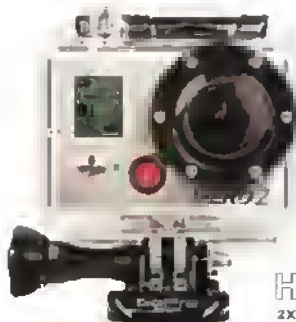
GoPro
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Adjust to find video, captured from camera mounted on weather balloon. Watch more on the GoPro Network at gopro.com.

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2X Sharper Glass Lens
2X Faster Image Processor
1080p | 960p | 720p | WVGA
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120 | 60 | 48 | 30 Frames Per Second
11MP Ten Photo Burst / Second
Wi-Fi BacPac™ + Wi-Fi Remote Compatible

gopro.com

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Wi-Fi Combo Kit
Wi-Fi BacPac + Wi-Fi Remote



LCD BacPac™



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3D HERO System



Chest Mount
Harness



HD HERO
Wrist Housing



Head Strap Mount



Suction Cup
Mount



Handlebar Seatpost
Mount



Vented Helmet
Strap

SOCCER



POWER KICKS

With 58 matches scheduled on six pitches at venues ranging from Wales to England to Scotland, 28 teams (16 men's, 12 women's) from six continents will compete in soccer at this summer's games, kicking 2700 balls provided by official Olympic sponsor Adidas. The Albert ball is an evolution of the 2010 FIFA World Cup model, the Jabulani, which was controversial among many players for its erratic trajectory, especially on hard strikes.

BALL CONTROL

The Jabulani used just eight spherically molded panels with shallow grooves (compared with 32 panels and deeper seams on a classic black-and-white ball). In a Caltech wind-tunnel study with the blower set to 30 meters per second (67 mph), the average speed of a pro kick, aeronautical

FLAT PASSING ZONE

RUBBER RIBS FOR CONTROL



engineers found that the Jabulani's smoother skin affected airflow in a way that caused erratic flight. "The rougher the ball, the more predictable it is," says lead researcher Beverley McKeon. (Consider the dimpled golf ball.) The Albert features 32 panels, thermally welded to prevent deformation; a new bladder is designed to hold air more consistently throughout a match and to absorb less water in rainy conditions. (Only two venues—London's Wembley and Cardiff's Millennium stadiums—have roofs.)

BETTER BOOT

Soccer's international governing body, FIFA, doesn't keep records of the fastest strikes, but elite players can drive in goals at nearly 100 mph. All that power relies on a smart boot for control. To design its new microfiber cleat, the Predator Lethal Zones, Adidas asked its top club players to draw, on plain white boots, the most important areas for various types of ball contact. On each of five key zones, layers of rubber and memory foam are textured to maximize the desired touch: A flat plate on the instep helps direct lower-velocity passes, while recessed rubber ribs around the forefoot add grip for dribbling, passing, and striking.

PopMech



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Family Values

Compact sedans are no longer the boring econoboxes of yore. The small-car segment is overflowing with stylish performers—and American nameplates are leading the charge.

AUGUST 2012 • POPULARMECHANICS.COM 64





LEFT TO RIGHT

**DOGE DART
CHEVY CRUZE LT
SUBARU IMPREZA
3
HONDA CIVIC EX SEDAN
FOCUS**

BY BEN STEWART

**PHOTOGRAPH BY
BEN STECHSCHULTE**

IN THE WAKE OF THE MASSIVELY PUBLICIZED FEDERAL BAILOUT OF GM AND CHRYSLER, American automakers emerged bruised and battered but also fiercely competitive. Just look at the current crop of compacts, a segment once dominated by a single car, the Honda Civic. That was then: Today's "American" compacts—the Chevy Cruze, Ford Focus, and Dodge Dart—are built using global expertise and must satisfy a worldwide customer base. In short, they have to be more than good; they must be excellent. And this trio has arrived just in time. In 2011, more than one in four new-car sales was a compact, and a mere six models totaled over 1 million new-car purchases. Plus, ever-rising fuel prices are only going to spur demand.

That gave us good reason to pit Detroit's finest against three great challengers—the Mazda3, the Subaru Impreza, and the Honda Civic. Does America finally have an answer to Japan's best? We hammered these six cars for a week of testing on Rust Belt highways and byways in order to find out.

2013 DODGE DART

The Bruiser



BASE PRICE/AS TESTED
▷ \$19,995/\$25,760

POWERTRAIN ▷ 160 hp,
184 lb-ft; 1.4-liter I-4

WHEELBASE (IN.) ▷ 106.4

LENGTH (IN.) ▷ 183.9

CURB WEIGHT (LB) ▷ 3288

0-60 MPH (SEC) ▷ 8.79

QUARTER-MILE (SEC/MPH)
▷ 16.34 @ 84.66

80-0 MPH BRAKING
(FT) ▷ 119.01

LANE CHANGE
(MPH) ▷ 57.98

EPA FUEL ECONOMY
(CITY/HWY) ▷ 27/39

PM FUEL ECONOMY
(MPG) ▷ 40.7



E

VEN THOUGH THE new Dart was outgunned at the dragstrip by the lighter Ford Focus and Mazda3 (the Dart is the bruiser of the entire group, outweighing the Civic by 500 pounds), it's still a rip to drive. Credit the tiny turbocharged 160-hp 1.4-liter engine pulled right from Fiat's hot 500 Abarth. The surge of turbocharged torque throws your head back as it peaks, and you reach for the next gear. Despite the extra heft, the Dart corners with little body roll, thanks to underpinnings based on the sporty Alfa Romeo Giulietta chassis. Those European roots make the Dart (tied with the Mazda) the car we'd most like to take for a lap around a racetrack. Even

electrically boosted steering didn't numb the feel. But the Dart rides more roughly over pockmarked roads than any car in our test, and it rattled over big bumps. Partial blame lies with the 45-series tires, the lowest-profile rubber of any model here. Inside, we liked the Dodge's Uconnect system and monstrously large navigation screen. When you're behind the wheel, this car feels spacious. And that's also true in the rear seats, where the Dart provided the most shoulder width of the group. (Headroom is limited, though.) The Dart requires buyers to trade comfort for sportiness—a tradeoff you might want to make, since this is the most entertaining car of the bunch.

VERDICT: Party animal Dart has a boisterous exhaust note and a punchy turbocharged engine. But the ride can get rough.

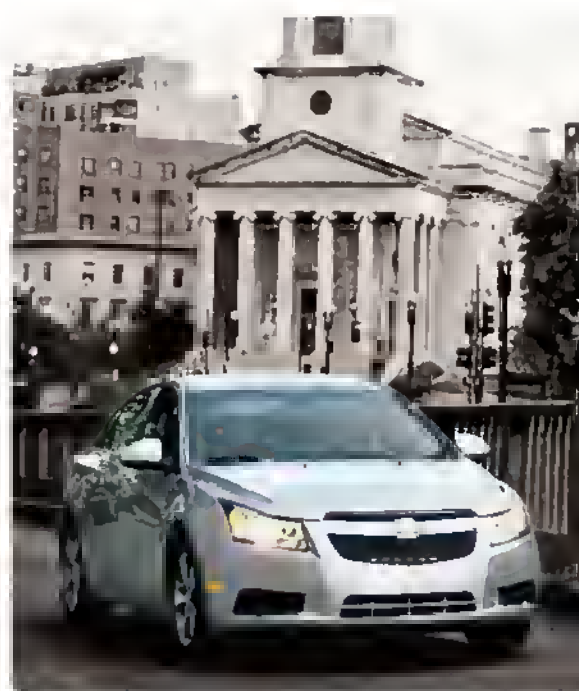


2013 CHEVY CRUZE LT

Smart Daily Driver

THE CRUZE SPLASHED onto the scene last year and already it has become the second-best-selling car in the class. And those 230,000-plus buyers aren't wrong. Americans like comfortable cars, and the Cruze was easily the best riding car of the bunch, absorbing jolts without drama (or passenger displeasure) and delivering the best compromise between comfy ride and reasonably taut cornering. The Cruze's steering requires only a light touch, so it's a pleasure to park and pilot. Though the Chevy uses a

small turbo like the Dart's, the personalities are as disparate as Brett Favre and Peyton Manning. The Cruze is quiet, subdued, and rock-solid—and the slowest car of the group. Although the 1.4-liter feels reasonably peppy around town, on the hills of our handling-test course the Cruze's automatic transmission had a tendency to hunt for the right gear. Inside there are pros and cons. We like the simple controls, but room is tight, especially aftward, where three adults can barely squeeze across the bench. Then again, trunk space won the test by a huge margin. Overall, the Cruze is one of the best compacts here. Its obvious quality has made us completely forget about the lackluster Cobalt and Cavalier that came before it.



VERDICT: The grownup of the group remains agile, reasonably peppy, and composed. But back-seat room is tight.

BASE PRICE/AS TESTED ▶ \$20,605/\$23,070 | POWERTRAIN ▶ 138 hp, 148 lb-ft; 1.4-liter I-4 | WHEELBASE (IN.) ▶ 105.7 | LENGTH (IN.) ▶ 181
CURB WEIGHT (LB) ▶ 3176 | 0-60 MPH (SEC) ▶ 9.47 | QUARTER-MILE (SEC/MPH) ▶ 16.93 @ 80.62 | 60-0 MPH BRAKING (FT) ▶ 121.47
LANE CHANGE (MPH) ▶ 60.66 | EPA FUEL ECONOMY (CITY/HWY) ▶ 26/38 | PM FUEL ECONOMY (MPG) ▶ 38.5

2013 MAZDA3

The Apex King



THE MAZDA IS the car you want to drive when you take the long way home. It has clearly been developed with a focus on driving fun. Bend the 3 through a set of switchbacks and the car corners flat. The steering feels alive in your hands, describing what the front tires are doing and how much grip is on tap. And since it's hundreds of pounds lighter than most here, the 3 feels nimble and tidy, while the other compacts are a lot less athletic. The sporty nature doesn't come at the cost of a comfortable ride when the road turns from buttered blacktop to a war zone. The interior is fairly silent over the worst roads—impressive. The Mazda's new 155-hp Skyactiv four-cylinder is not only efficient (39 mpg on our test loop), it ran through the quarter-mile traps quicker than any car here. So what's not to like? The interior. Controls are functional but a little boring. As with the Civic, the center screen on the dash becomes invisible in bright sunlight. The front-seat surroundings feel a little cramped too. And some testers felt the thrones could use more padding. A saving grace is that the rear seat was one of the roomiest for three. Overall this car offers way more good than bad. If we commuted where the roads were twisty, this would be our steed.

VERDICT: No doubt it's a fun car, but the 3 is also a quiet cruiser with the best steering. The interior? A bit dated.

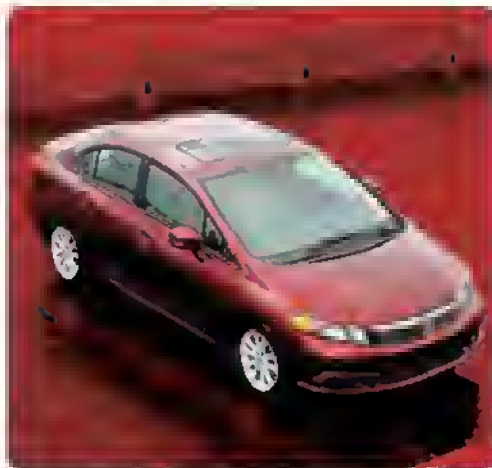
BASE PRICE/AS TESTED ▶ \$18,700/\$19,495 | POWERTRAIN ▶ 155 hp, 148 lb-ft; 2.0-liter I-4 | WHEELBASE (IN.) ▶ 103.9 | LENGTH (IN.) ▶ 180.9
CURB WEIGHT (LB) ▶ 2868 | 0-60 MPH (SEC) ▶ 8.55 | QUARTER-MILE (SEC/MPH) ▶ 16.17 @ 86.83 | 60-0 MPH BRAKING (FT) ▶ 134.96
LANE CHANGE (MPH) ▶ 58.58 | EPA FUEL ECONOMY (CITY/HWY) ▶ 27/39 | PM FUEL ECONOMY (MPG) ▶ 39.1

2013 HONDA CIVIC EX SEDAN

The Fuel Miser



TIME HAS NOT been kind to the Civic. Its once-rewarding chassis—so good that it became one of the pillars of the sport-compact movement—has been more defanged with each generation. After a snaky back-road stint in the Honda, you yearn for the communicative steering of the Mazda, Dodge, or Ford. The Honda's numb tiller, as one tester put it, "feels as though there's a rubber band wrapped around the steering column as you turn." The Civic rolls quite a bit in corners, but it is feathery (the lightest car here by 115 pounds), and that keeps the Honda from feeling ponderous on good roads. But fun? Nope. At least it's one of the comfiest cars here when pavement quality suffers, although on those occasions the cabin boomed with noise, while the better competition was quieter. The Civic's futuristic digital gauges look like they belong in a hybrid. Trouble is, in certain sunlight conditions they get washed out; the simplicity and depth of analog instruments don't typically suffer from this problem. In the back seat, the Civic was very tight for three large guys—especially in the headroom department. And it had the smallest trunk of our test group. But for all its faults, the Civic positively sips fuel. On our 340-mile economy run, it returned almost 43 mpg. That's solid.



VERDICT: The once-venerable Civic—fun, tossable, and cute—has now become a merely comfortable, frugal commuter.

BASE PRICE/AS TESTED ▶ \$20,505/\$21,275 | POWERTRAIN ▶ 140 hp, 128 lb.-ft.; 1.8-liter I-4 | WHEELBASE (IN.) ▶ 105.1 | LENGTH (IN.) ▶ 177.3
CURB WEIGHT (LB.) ▶ 2753 | 0-60 MPH (SEC.) ▶ 9.45 | QUARTER-MILE (SEC./MPH) ▶ 17.01 @ 81.73 | 60-0 MPH BRAKING (FT.) ▶ 128.25
LANE CHANGE (MPH) ▶ 59.6 | EPA FUEL ECONOMY (CITY/HWY) ▶ 28/39 | PM FUEL ECONOMY (MPG) ▶ 42.7



2012 SUBARU IMPREZA

Snow-Belt Champ



WHILE SUBARUS WERE once as quirky as Saabs, the latest Impreza is perhaps the most mainstream car in our group—save that unlike any other car here, it comes with standard AWD. For 2012 Subaru also cured the old Impreza's poor fuel economy. An available CVT boosts combined mileage to 30 mpg, a 25 percent gain over the 2011 model. The new car's cockpit is airy, with a steering wheel that tilts and telescopes

with more range than any car here—offering near-luxury-sedan adjustment. The entire car feels comfortable; there's plenty of leg and shoulder room as well as big doors that open wide. Under the hood is a 2.0-liter flat-four-cylinder—but it's not WRX-nasty. This boxer engine is tuned for efficiency. Ours came paired to a five-speed manual that worked well, but opt for the CVT and you'll get even better fuel economy. Besides, the manual doesn't add much sportiness, as the engine dislikes free spins to redline and the soft suspension rolls on sinuous back roads. It corners if it must, but it's no sports car. By contrast, it's rock-solid over brittle asphalt, where the Impreza is at least as composed as the Chevy. And if what you need is a spacious compact that delivers all-wheel-drive traction, this is the one.

VERDICT: The Impreza delivers a solid—rather than sporty—ride, a spacious cabin, and, of course, all-wheel drive.

BASE PRICE/AS TESTED ▶ \$19,095/\$21,914 | POWERTRAIN ▶ 148 hp, 145 lb.-ft.; 2.0-liter I-4 | WHEELBASE (IN.) ▶ 104.1 | LENGTH (IN.) ▶ 180.3
CURB WEIGHT (LB.) ▶ 2981 | 0-60 MPH (SEC.) ▶ 9.25 | QUARTER-MILE (SEC./MPH) ▶ 16.85 @ 80.72 | 60-0 MPH BRAKING (FT.) ▶ 114.52
LANE CHANGE (MPH) ▶ 60.23 | EPA FUEL ECONOMY (CITY/HWY) ▶ 25/34 | PM FUEL ECONOMY (MPG) ▶ 37.10

2013 FORD FOCUS

A Showstopper



BASE PRICE/AS TESTED
▷ \$17,270/\$20,580

POWERTRAIN ▷ 160 hp,
146 lb-ft; 2.0-liter I-4

WHEEL BASE (IN.) ▷ 104.3

LENGTH (IN.) ▷ 178.5

CURB WEIGHT (LB) ▷ 2966

0-60 MPH (SEC) ▷ 8.19

QUARTER-MILE (SEC/MPH)
▷ 16.25 @ 86.41

60-0 MPH BRAKING
(FT) ▷ 118.15

LANE CHANGE
(MPH) ▷ 60.66

EPA FUEL ECONOMY
(CITY/HWY) ▷ 26/36

PM FUEL ECONOMY
(MPG) ▷ 40.9

PopMech
TOP PICK



T

HE EDGY FOCUS, with its elegant lines and sporty proportions, looks like it just rolled off the streets of Milan. It was one of our favorite designs. But beneath the skin, the Focus was equally appealing. This was very much the all-star of our group, finishing at or near the top of every performance test and subjective rating we could throw at it. It was the quickest compact to 60 mph, and yet it nearly matched the Honda's fuel economy. And that's not easy to accomplish, especially since the Focus gets a five- rather than six-speed transmission. But the car's well-spaced gears and strong 2.0-liter four never felt overmatched on rolling hills or over-revved on interstate hauls. Grab the Focus's thick-rimmed steering wheel and you'll expect this to be a fun ride. Good thing the Focus doesn't disappoint. Ours came with a \$1130 Sport Package, which helped make the Ford a frisky partner on twistier roads. The Focus's reflexes might be slightly duller than those of the Mazda, but the incredibly competent Ford delivers excellent grip and can be pushed very hard without overmatching its 17-inch rubber. Inside, the Ford's interior looks fresh and more cockpit-like than any other car here. Downside? Sporty cabins feel less airy. The upside includes front seats that were easily the most comfortable, offering deep bolsters and soft, supportive cushions. We could drive across the country in these seats and never have a backache. And the rear seat is roomy enough for three. Unlike with some of the equally talented performers here, handling poise does not translate into a rougher ride. Though the Ford's dash was a tad buzzy over the worst roads, the ride was firm. The Focus excelled by nearly every measure, and, as an added bonus, that goodness comes at a nice price: The Focus has the lowest MSRP here. **PopMech**

VERDICT: The happiest medium—the Focus gets a sporty ride but not at the cost of comfort, room, or style.

LIFE

AT

THE

EPICENTER

Earthquakes are inevitable, but very few people living near a major fault take steps to protect their families and homes. Preparing for the big one can mean the difference between safely riding it out—or losing everything.

THE PEEPS WERE MOVING. It was Easter Day, 2010, and I was at a potluck brunch not far from downtown Los Angeles. It was characteristically sunny and warm, and many of the guests had settled into the host's backyard garden. I was one of a half dozen people sitting at a wooden picnic table when the shaking began. At first I thought it might be nausea. I was four months pregnant and had already eaten one too many of the sugary marshmallow chicks. Then I saw that everything on the table was vibrating.

Earthquake.

Little about it was scary. In fact, the sensation was mildly pleasant, just a mellow undulation, like standing on a floating dock as a spent motorboat wake rolls through. In seconds, it was over.

Soon other guests filed out of the house. "Did you feel that?" people asked one another. A lot of them hadn't noticed a thing, but I was thrilled. After three years in L.A., it was my first true earthquake. Phones were fished from pockets and purses and Twitter feeds consulted. This was the real thing, a 7.2-magnitude tremor that originated in Mexico, 6 miles beneath the Baja Peninsula. There was some damage near the border, but Los Angeles had been spared. A few days later, my husband, Dan, and I were sitting in our living room when an aftershock hit. We briefly locked eyes, then





BY
KALEE THOMPSON

ILLUSTRATIONS BY RANDY ORTIZ

turned our gaze to the darkened TV. We had recently bought our first flat-screen, and dutifully used \$20 earthquake straps to secure it to the mantel above our defunct fire-place. They worked. The shaking stopped. Everything was fine.

THE PAST FEW YEARS HAVE been turbulent ones for the planet. Earthquakes have caused massive devastation, killing 86,000 people in Pakistan in 2005; 87,000 in China in 2008; and close to 100,000 in Haiti in 2010. In the two highest-profile earthquakes of the past decade—the 2004 Sumatra quake and the 2011 Tōhoku event in Japan—most of the death and destruction were caused by a subsequent tsunami, a rare geological phenomenon that to most Americans seemed as bizarre and otherworldly as an asteroid strike. Four of the 13 most deadly earthquakes in history have occurred since 2004—a statistic that says less about Earth than about how humans live on it. Growing populations and dense urban centers create greater hazards from natural disasters. (Even the strongest earthquake poses little danger to a person alone in a field.) When major quakes strike, as they inevitably will, people-packed cities like L.A. are most vulnerable.

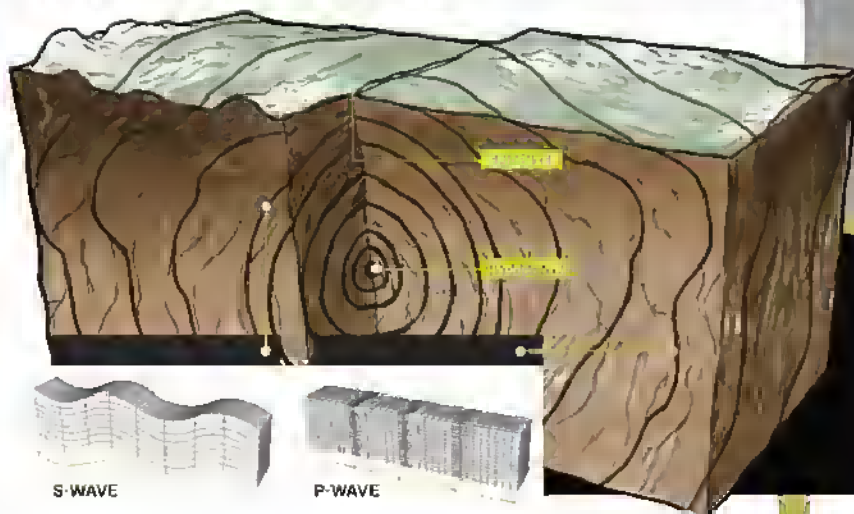
Long before I moved to California I knew that earthquake-probability maps show the Pacific Coast traced in red, reflecting the major fault lines that form where tectonic plates abut. But until recently, I hadn't looked into the specifics: Seismologists estimate there's an 82 percent chance that a magnitude-7 or greater quake will hit directly beneath Southern California in the next 30 years. Three-quarters of all U.S. earthquake losses are expected to occur in the state, and experts' best-guess estimate is that damages will exceed \$30 billion per decade on average.

Meanwhile, Americans have been reminded that earthquakes aren't purely a California hazard. In August 2011, a 5.8-magnitude tremor struck near Richmond, Va.

That quake, felt from Georgia to Quebec, was the largest to hit the Southeast in more than a century. Using new paleoseismic data and more complex computer-forecasting techniques, the U.S. Geological Survey (USGS) is refining risk estimates for places such as the Cascadia subduction zone off the Pacific Northwest coast, the Wasatch fault near Salt Lake City, and the New Madrid seismic zone, extending from southern Illinois into Arkansas, which experienced four magnitude 7 quakes back in 1811 and 1812. Of course, probabilities tend to have less impact than personal memory of actual events, and throughout the U.S., it's been a time of relative quiet. The last earthquake to cause significant havoc was the 6.7-magnitude Northridge quake, which killed 57 people and delivered \$20 billion in damage to the Los Angeles area in 1994. That mild Easter Sunday tremor in 2010 turns out to have been the most powerful earthquake to touch Southern California in nearly 20 years.

The same month, Dan and I were in the process of buying our first home. To us, the property was charming: a peak-roofed, light-filled house perched atop an ivy-smothered slope. We didn't mind the steep, uneven stairs that led to the front door, or the cracks in the flaking stucco and the concrete patio. For a house built in 1927, such scars seemed minor. We were pleased to learn that the building had been bolted—the foundation attached to the wooden frame with a series of struts and bolts. The job wasn't to code, but overall it looked pretty good, our home inspector told us. We reviewed insurance options. A basic policy would run us \$550 a year. Add earthquake insurance and the cost more than doubled. We had a decent idea of worst-case scenarios: Friends had been “red-tagged” after Northridge, when authorities marked 1600 homes as uninhabitable and forbade residents to return. Still, what were the chances of that happening again? Of it happening to us? Looking more closely at the quote, I saw that the deductible for our home would be close to \$50,000. Justifying the decision to forgo earthquake insurance wasn't difficult. The house has held up for this long, we rationalized. Something truly catastrophic would have to happen to make that expense worthwhile.

EARTHQUAKE MECHANICS



STILL, EARTHLY HAZARDS HAD SEIZED MY attention. In the past, I'd been exasperated by my East Coast family's concerned phone calls following news coverage of Southern California's forest fires. "That's nowhere near us! We're completely safe," I'd reassure them (though once we could see distant flames from our apartment's front porch). Now, though, I was the one worrying. The financial gamble of homeownership was part of it. The other was my son, Otto, who was born a few months after we moved into our new home. For the first time, I compiled a household earthquake kit, adding a week's worth of extra diapers, wipes, and baby food to the stockpile of water, flashlights, and first-aid supplies. I made room in the trunk of our hatchback for a basic survival kit including energy bars, a fire extinguisher, sneakers, more diapers, and a couple of 2-gallon water jugs, and studied the emergency-shutoff directions for our gas line and water heater. When the 9.0-magnitude earthquake, tsunami, and nuclear disaster struck Japan in March 2011, Dan and I half-jokingly debated the pros and cons of stocking up on plastic sheeting and duct tape. Nuclear disaster planners recommend a shelter-in-place approach to radiation plumes. But our house has neither a real basement nor any windowless rooms. Maybe sealing off our drafty, old-fashioned swing-open windows would help?

Did we think dangerous fallout from the Fukushima Dai-ichi power plant might actually stretch across the Pacific? (Some members of an online moms' group I lurked in were convinced it was already happening.) Or were we more concerned about a similar "unforeseen" disaster at the San Onofre nuclear power plant 60 miles to the south? (News that it had been built to withstand a magnitude-7 earthquake suddenly didn't sound so impressive.) I'm not really sure. Both of those possibilities seemed outrageously unlikely—yet it was foolish to completely dismiss them. What I knew to be true was that radiation exposure poses especially high risks for small children. Otto was 6 months old.

When I saw a flier advertising a free emergency-preparedness class at the local library, I signed up. Over seven evenings, I sat between an elderly Japanese couple and a row of aging hippie types as an L.A. firefighter schooled us on various disaster scenarios. We practiced triage and first aid with what struck me as a somewhat lofty idea that when the big one hit, all of us—informed, diligent citizens that we were—would be providing crucial backup to first responders. Gory videos of car crashes and building collapses were the backdrop to discussions on how to treat head trauma (the No. 1 earthquake injury, our instructor said); how to make or find potable water

"Losing a major city [to an earthquake] would be hard for somebody to even imagine today. Maybe some people would say that it's impossible. But I don't think anybody actually knows that."

—TOM HEATON,
CALTECH SEISMOLOGIST



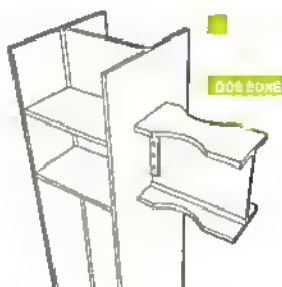
when utilities are cut off (mine your water heater); and the California laws governing defecating in your own yard (illegal! my live-free-or-die New Hampshire relatives would be outraged). But I also had a more fundamental question about earthquakes: What were the odds I'd ever have to use these skills?

IN MORE THAN 30 YEARS AT the California Institute of Technology, seismologist Tom Heaton has developed a reputation as something of an earthquake maverick, with expertise in both geophysics and engineering. He's a large man, with suspenders that stretch over his neatly pressed dress shirt and a soft, jowly face framed by a cloud-like crown of white hair. I'm hoping Heaton will provide some straightforward facts to help me frame our mutual earthquake risk. Instead, he leans back, obviously bemused by a question he's heard too many times before. "It's almost like asking how big is the risk from wars, how big is the risk from epidemics," Heaton says. "When we look at the statistics of earthquake problems, they're the kind where things

EXCESSIVE PRESSURE BETWEEN TECTONIC PLATES can cause them to slip and the ground to rupture. A series of seismic waves emanate from this hypocenter (as opposed to the epicenter, the point directly above that on the surface). Fast-moving primary, or P-waves, reach seismograph stations first, and like lightning preceding thunder, can provide valuable seconds of warning before the real shaking begins. P-waves cause rock to expand and contract as they pass through it. Secondary shear, or S-waves, displace material at right angles to their path and reach the surface later. They undulate along Earth's crust much like ocean waves and, as a result, they cause the most damage.

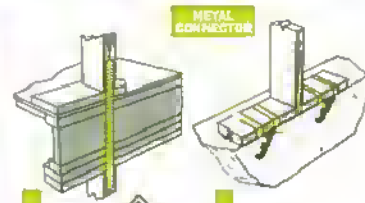
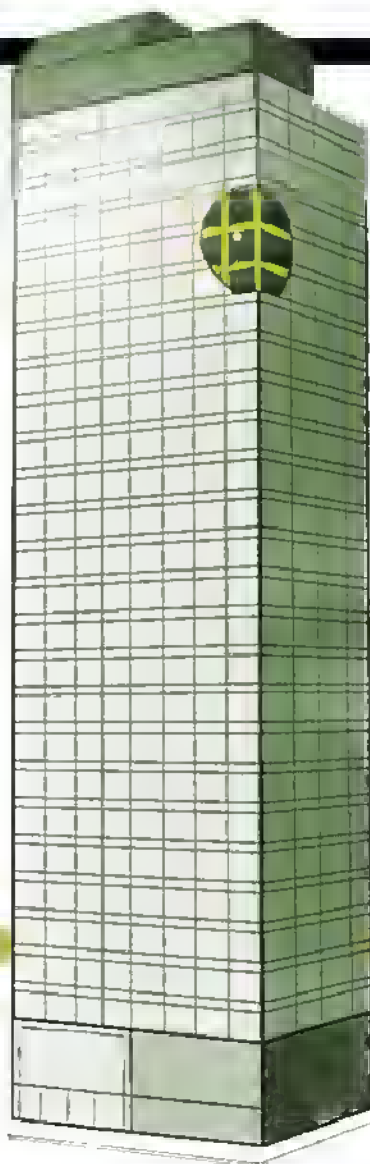
IMPROVE YOUR EARTHQUAKE IQ

Building codes were not always so rigorous—especially in earthquake-prone areas. Here's how to eyeball the risk posed by various structures.



A SKYSCRAPER'S CREDENTIALS AREN'T VISIBLE

from the sidewalk, but you can rest assured that steel is more pliable than brick or concrete, and that modern skyscrapers are subject to stringent seismic standards. "You don't just want to build something that's stronger, you want to be able to control where it gives," engineer Aaron Reynolds says. To do that, architects add "dog bones"—areas of reduced width on the building's steel beams. These weak zones absorb shaking, diverting strain from its welded joints. If you're inside a high-rise during a quake, stay put; you run a greater risk of being hit by debris outside.



ONE OF THE SAFEST PLACES TO BE

during an earthquake is inside a well-made wood-framed home. Metal connectors join the floors and walls in newer houses; older ones have often been professionally retrofitted, or bolted. This creates what's called a continuous load path, in which the frame of the house moves as a single unit during tremors. Hardware should also connect the foundation and mudsill to wall studs, work that can be easily seen from the basement.

that don't happen very often end up being incredibly important."

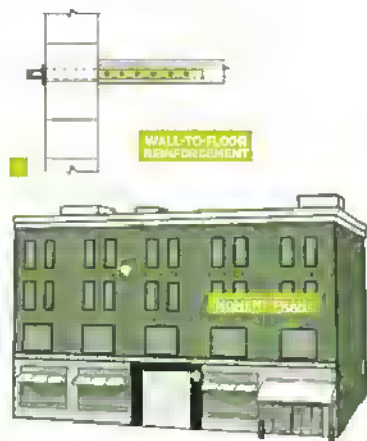
Recent U.S. seismic history doesn't give us any real clues as to what lies ahead, Heaton says. "In the last century, we've only had deaths in the hundreds. But if you look at 1906, the largest city in the western U.S. was basically wiped out by an earthquake. Losing a major city would be hard for somebody to even imagine today. Maybe some people would say that it's impossible. But I don't think anybody actually knows that."

I ask Heaton what he thinks about my earthquake-insurance rationalization—that my house has endured 80 years of shaking, and so can probably hold up for the four or five more decades that Dan and I will be around. He smiles. "Oh no, that doesn't really tell you anything," he says. It's no accident that earthquake-probability forecasts use a 30-year time frame, the same as the typical home mortgage. Heaton has been intimately involved

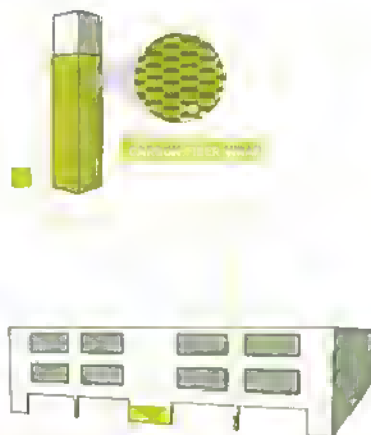
with the complex number-crunching responsible for those statistics, and while the figures undoubtedly help citizens evaluate risk—and engineers set building code standards—he is the first to admit that the forecasts are perplexingly vague. "I've fallen asleep a hundred times with those numbers," he says. "We argue and arm-wrestle. There's a million compromises." A magnitude-7 quake, after all, may be a neighborhood-flattening jolt or just another fun party story, depending on where and when it comes.

Heaton has raised three children in a Pasadena home built in 1910. He doesn't have earthquake insurance either. He used to, up until 1991, the year the 5.6-magnitude Sierra Madre earthquake damaged his home. "It broke some foundation; it destroyed the chimney," he says. "By the time it was done, it caused several tens of thousands of dollars in damage, and earthquake insurance paid for that. It was a good deal." Since then, the price of earthquake insurance has gone up, along with deductibles. Heaton and plenty of other Californians calculated that it made more sense to invest in upgrades that would protect against future quakes than to pay a skyrocketing monthly premium.

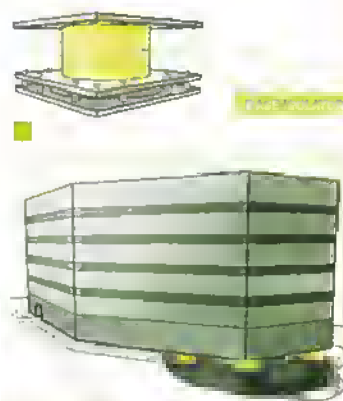
INTENSE SHAKING CAN CAUSE OLD masonry walls to crack, crumble, and collapse. Brick buildings can be strengthened with concrete and have steel "moment frames" installed around storefronts. Often, steel wall-to-floor reinforcements are visible from the street, where sandwich-size metal plates delineate the line between stories. While such retrofitting work is often mandated by building codes, there are still old brick buildings with little or no quake reinforcement.



WITHOUT SUFFICIENT METAL REBAR, required by most building codes after the 1970s, concrete buildings are prone to pancaking. The risk is often higher in a building with a "soft" first story—one with high ceilings and multiple openings. Though rebar isn't visible, other reinforcement is: Contractors adhere carbon fiber to concrete walls and posts. "It looks like somebody glued on a burlap bag," Reynolds says. You may also see shear walls bracing the soft first story.



A BUILDING WITH BASE ISOLATION rests atop a series of flexible rubber cylinders; these act as a suspension system, turning violent jolts into subtle vibrations. The approach is the gold standard for hospitals, schools, and buildings that contain computer servers, refrigerated medical samples, and other valuable equipment. Such buildings are usually surrounded by a concrete moat at street level—look for a tiny gap in the sidewalk a few feet from the building's exterior walls.



Though it's our homes we fret about most, they're usually the least vulnerable—at least single-family, wood-frame houses like the ones Heaton and I own. "Wooden houses are extremely resilient to earthquake shaking. It's almost unheard of that they actually collapse," he says. Far more dangerous are unreinforced brick structures and what engineers refer to as nonductile concrete buildings. Had the Northridge earthquake occurred during the workday rather than at 4:30 am, studies concluded, there would have been 20 to 30 times the fatalities. The same principle will likely apply when the inevitable big one strikes. A study that simulated a 7.9-magnitude rupture on the San Andreas fault (a repeat of the 1906 San Francisco quake) calculated that 8000 people would be seriously injured and 1800 killed if it occurred at night. If it struck during the day? Expect 12,500 injured and 3400 dead.

NOT LONG AFTER THE JAPAN DISASTER, I FELL into conversation with the wife of a UCLA seismologist at a friend's housewarming. Her husband, the woman told me, had been part of a study that identified the most collapse-prone buildings in Los Angeles. Maps existed, but city officials didn't want the public to know about them. In the weeks that followed, I often found myself examining buildings as I drove L.A.'s surface streets, looking for signs of seismic reinforcement. In restaurants and shops, I'd try to guess the age of brick and concrete, wondering if I might be lingering over a sandwich inside a structure on the secret danger list.

Eventually I tracked down the study in question, as well

as one of its lead authors, Mary Comerio, a professor of architecture at the University of California, Berkeley. In her view, the building list wasn't quite the scandal I'd imagined over my second glass of wine. It's a research database that was never meant to be public, she tells me. The effort is part of a much larger project tasked with figuring out how to classify concrete buildings by their risk level.

The number of potentially hazardous buildings in Los Angeles is small compared with that of many other cities, Comerio says. "Los Angeles has had a very aggressive public retrofit program. So every public building in the city has either been retrofitted or replaced." Because of what she calls L.A.'s big adaptive reuse program (also known as the downtown hipster invasion), lots of warehouses have been converted to residential lofts; planning code requires that such change-of-use conversions be seismically retrofitted. It turns out

that Los Angeles' future-oriented, growth-focused character makes it a safer place to live. "Los Angeles, frankly, tears down more buildings than a city like San Francisco," Comerio says. The latter has about 3,000 nonductile concrete buildings, twice the number in L.A.

I still wondered why the inventory couldn't be made public. When the research is complete, it will go into an open database. The building addresses, though, will be stripped out. "There are privacy issues," Comerio says. "The minute it gets in the public realm, somebody is going to say, this is a list of dangerous buildings. That's not what we're saying; we're saying this is a list of buildings we're studying."

Heaton had been less politic when I posed a similar question to him at Caltech: Say you wanted to rent an office space in downtown Los Angeles—is there a database

that could help you identify which buildings are more or less safe? "No, you're toast. You're hosed," he said. "There should be, but the politics of it are such that nobody has been able to push that through."

Determined to improve my own assessment skills, I meet seismic engineer Aaron Reynolds in the lobby of the Walt Disney Concert Hall. Reynolds's firm designs hospitals and schools and retrofits older buildings for seismic safety. As the result of improved building codes, it's typically not the primary structures that are the problem these days, he tells me. In recent decades, nonstructural damage, like broken ducts and water pipes, has been more costly. "I think there's a lot of confidence that [newer] buildings are going to perform fairly well," Reynolds says as we stand on the sidewalk beneath Frank Gehry's glimmering suspended-metal sails, gazing toward the compact cluster of downtown skyscrapers. "Collapse is just unacceptable."

We walk a few blocks to Temple Street and the city's fortress-like Roman Catholic cathedral. Reynolds stops a few feet from the exterior wall and points out a small gap in the sidewalk; it marks the edge of a several-foot-wide concrete moat surrounding the building's base. He makes a crude sketch on his iPad. The monolith rests on rubber cylinders known as base isolators, which act as a suspension system for the entire structure. During an earthquake, the isolators will

PLAN, PREPARE, SURVIVE

Preparing for disaster is on lots of people's to-do lists. But less than one-fifth of households compile an emergency kit sufficient for a large-scale catastrophe—or practice for one. Sign up for the Great ShakeOut (shakeout.org), an earthquake drill held in 15 states on Oct. 18, and a free, community emergency-response class (citizencorps.gov/cert). Here are more tips for riding out a quake safely.

BEFORE THE BIG ONE

Furniture: Use wall straps and museum putty, such as those sold by QuakeHold, to secure valuables and stabilize tall furniture. Head injuries caused by falling objects are a common trauma.

Emergency kit: Companies such as Ready America and SOS Survival Products sell kits, but it's often cheaper to compile your own. Use a weatherproof container, such as a plastic garbage can, to store supplies, including a battery- or hand-powered radio (some double as cellphone chargers), flashlights, spare batteries, canned food, a manual can opener, first-aid supplies, and plenty of heavy-duty trash bags. Also keep photocopies of vital documents and prescriptions and a couple

hundred dollars in small bills on hand.

Water: Estimate 1 gallon per person per day for at least 10 days, and store the water separately from other supplies.

Bedroom: Keep shoes and a flashlight near the bed. Lacerated feet were the most common injury during California's Northridge quake. Use closed-loop hooks for framed art, and avoid hanging anything heavy above beds.

Kitchen: Use cabinet latches to keep glassware from toppling out and shattering. Avoid storing ammonia, bleach, or hazardous supplies on high shelves where they could spill.

Cellphone: If you use Facebook or Twitter, begin

following local utility and emergency service agencies now. In recent disasters, social media sites have been the best source of information.

Utility room: Use metal straps to secure your hot water heater to wall studs. Keep fire extinguishers where they're easily accessible.

AFTER THE BIG ONE

Wall phone: Landlines will be more reliable than cell service (though you may get text messages to go through even when calls won't). All family members should know the number of one out-of-state contact who can relay that everyone is okay.

Utilities: Turn off water, electricity, and—if you smell a leak—gas. Fire is a real danger during the aftermath

of an earthquake, when firefighters will likely be overwhelmed with other calls. Put a wrench inside a plastic bag, tape it just above your turnoff valve, and be sure your family knows how to use it. If there's no evidence of a leak, however, leave the gas line on. A functioning stovetop will be helpful if the power remains out for an extended time.

Backup H₂O: The typical water heater contains 32 gallons of potable water. The water in your toilet tank is replaced after each flush and is also generally safe to drink. Gone through that? Regular household bleach can make the dirty drinkable. Add 16 drops bleach to 1 gallon dirty water, strain, and sip.

Porta-Potty: Using your backyard as a bathroom will likely get gross fast. Instead, line a bucket or your dry toilet bowl with a heavy-duty trash bag. Add a little cat litter. Go. Repeat. When full, seal the bag and store separately from your other garbage.



Seismologist Elizabeth Cochran specializes in earthquake physics. Her Quake-Catcher motion sensors attach to home computers, turning them into a network of seismic stations. To request a sensor, visit qcn.stanford.edu.

absorb most of the energy. The moat of concrete is designed to shift as needed—up to several feet—to give the building room to move. "Everybody jokes about the drunk person in an accident; he's the one who doesn't get hurt," Reynolds says as the cathedral's bells begin to chime. "It's the person who's not drunk who ends up being injured because he stiffens up." A building is similar. "Stiff buildings absorb a lot of earthquake energy. With the isolation system we make it soft."

IN THE AFTERMATH OF THE TÔHOKU DISASTER, I kept hearing how Japan had the most advanced earthquake-early-warning system in the world. Information from a vast network of sensors automatically stops trains, shuts down utilities, and sends text and email alerts to citizens soon after a significant quake begins. The lead time is typically just tens of seconds, the time between a fault slipping and the ground waves hitting population centers. But that's enough to save lives.

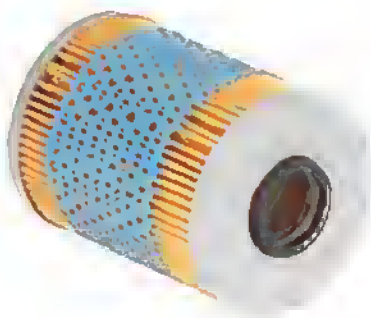
Scientists have talked about installing an early-warning system in California for decades, but the political will is lacking. It may be that society still holds out hope for true prediction, a word I find causes most seismologists to take a deep, nerve-calming breath. Despite reports of prescient runaway pets, we remain unable to predict specific seismic events. Early warning is our best hope, but experts are pessimistic that the funding (at least \$80 million) will materialize before another big quake hits. "If you look at the systems in other countries, they're generally a result of a killer earthquake," USGS seismologist Doug Given says. "The Mexican system resulted from the '85 earthquake that killed about 9500 people. The Japanese system was the result of Kobe, which killed 6400 in 1995. It's our hope that a bunch of Americans don't have to be killed before we build one."

Elizabeth Cochran's office is a 5-minute walk from Heaton's on the Caltech campus. Cochran invented the Quake-Catcher Network—a citizen science project in which

thousands of people attach match-book-size sensors to their desktop computers. When many sensors in close proximity detect similar shaking at the same time, it's likely a real quake rather than random jostling. The day before my visit, there had been a 4.0-magnitude earthquake north of San Francisco; within 8 seconds, Quake-Catcher data pegged it at a fairly accurate 3.7. "The idea is that once, or if, it's found to be reliable, this could feed into an early-warning system," Cochran says. After an earthquake, seismologists create shake maps that show the strength of the ground motion in different areas. "Right now those are highly interpolated," she says. "There are stations 50 kilometers apart and you're essentially guessing the ground motions in between." A vast network of Quake-Catcher sensors could add valuable resolution to those maps, identifying where to send firefighters, EMTs, and transportation inspectors first.

I leave Cochran's office with a sensor of my own. Over the next few weeks, I work on my family's earthquake kit, stashing several extra 5-gallon water jugs in the backyard. I rearrange the furniture in Otto's bedroom so that his crib is no longer next to the pane-glass windows. I call two different retrofitting specialists to take a closer look at that ad hoc bolting job beneath our house. Contractor One seems genuinely impressed by the work and tells me that if it were his house, he wouldn't do anything more. Contractor Two, a well-respected local named Greg Sylvis, has specialized in retrofitting for three decades. He is more critical.

"A lot of times they'll just do the part you can see from the door," Sylvis says as he pulls on kneecaps, a headlamp, and a face mask, then shimmies into the foot-high crawl-space at the rear of the house, over soil littered with ancient Gatorade bottles and opossum scat. He finds no shortage of hardware, but much of it is extraneous, installed



✓Yes



✓Yes



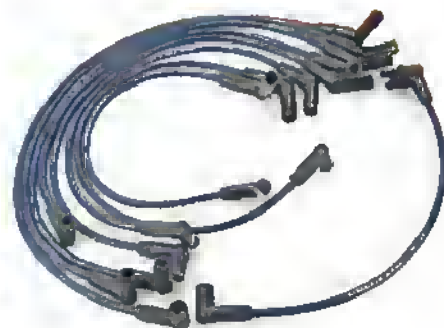
xNo



✓Yes



✓Yes



✓Yes



✓Yes



✓Yes



✓Yes

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Here's how to get stereoscopic content—for less. **p. 80**

The guide to your DIY life!

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W
weekend

TECH ADVENTURE HOME SCIENCE AUTO

Nothing satisfies quite like a neatly groomed yard. Our string-trimmer test will help you find the right tool for the job. **p. 97**

HOME

Stop those darn crooks from raiding your vacation cabin. **p. 100**

SCIENCE

Why you should stop worrying and love the Volt. **p. 113**



Q+A

Our experts tackle your toughest tech, home, and auto questions. **pp. 86, 100, and 113**

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20 WAYS
TO TAKE
BETTER
PHOTOS

The camera doesn't create great images, the photographer does.

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See this catapult? It's really fun to build, especially as a project for kids. **p. 98**

ADVENTURE

Just because you're out in the woods doesn't mean you can't cook a great steak. **p. 90**

SCIENCE

Explore Saturn, the Milky Way, and even the Andromeda Galaxy with just a pair of binoculars and a star chart. **p. 104**

Photos flood the Web

On Flickr users upload over 1.5 million images a day with these brands:

Canon
43,973 users
Nikon
27,541
Apple (mobile)
11,144
Sony
858
Olympus
3263

HOME

STOP TALKING ABOUT BUILDING A PERGOLA AND DO IT—NOW! **p. 92**



dig

Tech

- FACEBOOK HIJACKING
- PHOTO-TAKING TIPS
- APP ERADICATION



BY GLENN DERENE

SO YOU BOUGHT A 3D TV... NOW WHAT?

HOW TO GET STEREO-SCOPIC CONTENT WITHOUT OVERHAULING THE REST OF YOUR HOME THEATER.

Y

You may, in the next few years, purchase a 3D TV—and not even realize it. In 2010, the first wave of 3D TVs hit the market with much fanfare, but customers largely yawned—the sets sold at a premium, stereoscopic content was limited, and the glasses required to view 3D were complicated, uncomfortable, and expensive. Tech pundits declared 3D TV stillborn. But a funny thing has happened in the past two years: A growing number of manufacturers have started to integrate 3D functionality into their sets as a matter of course. What was once a premium option is becoming the norm.

Now, just because your new set has 3D capability, that hardly means you have to use it. I expect most 3D sets will spend the majority of their time displaying flat video—most 3D sets are also no-compromise 2D sets. But leave a bunch of glasses splayed out on your living room coffee table and family members are bound to get curious. What can we watch with these things? Is there a way to get a little stereoscopic entertainment without shelling out a fortune for discs and extra components?

Equipment

Before we can answer the question of what to watch, it's worth asking: Do I have the right equipment to watch 3D? For sure, you've got the TV, but if it were up to the electronics industry, the purchase of a 3D TV would trigger a secondary buying binge of a 3D-capable Blu-ray player, a new home theater system, and maybe even a 3D video camera. The good news is that the price of

in

WEEKEND



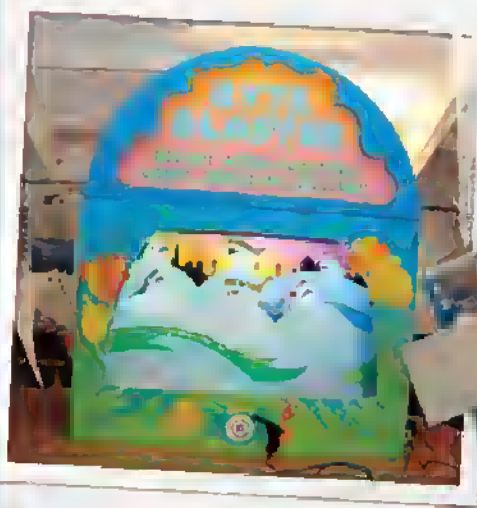
The logo features a large red 'R' inside a white circle with a red border, set against a black background. Below the 'R' is the word 'RadioShack' in white. The words 'EAST WEST' are written in large, bold, red letters. Below this is a small black box with the word 'VS' in white. The word 'HACKERSPACE' is written in large, bold, black letters. At the bottom, the word 'CHALLENGE' is written in large, bold, red letters. The entire logo is framed by a black border with white circuit-like lines.

In the spirit of friendly competition, RadioShack challenged two DIY enthusiast groups known as hackerspaces—one on each coast—to build something cool out of everyday stuff. The rules were simple: use parts from RadioShack, including an Arduino (an inexpensive programmable device that can be used for all sorts of interesting interactive projects).

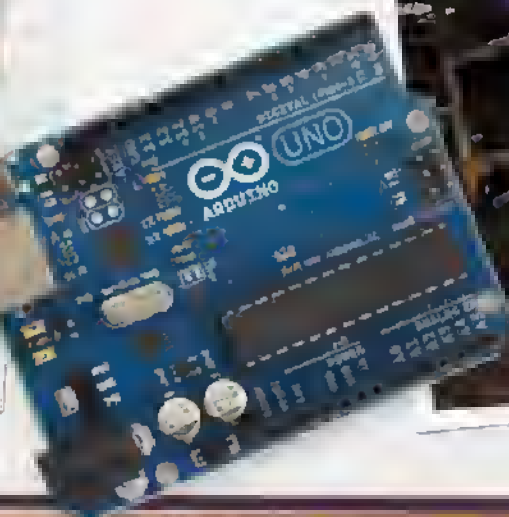
Our two teams come from the **Ace Monster Toys** hackerspace in Oakland, California, and **Artisan's Asylum** in Somerville,

Massachusetts (just outside Boston). Each team was given a \$250 RadioShack gift card and one month to dream up, design and build their project. They both did an amazing job and used parts they found at RadioShack in unique and creative ways.

Look inside to see what each team created! The winning team will receive \$1000 and one lucky voter will receive a \$1000 RadioShack Gift Card!



TEAM WEST



TEAM EAST

**VOTE FOR YOUR FAVORITE  RadioShack.
PROJECT, AND GET A CHANCE TO WIN A \$1000
RADIOSHACK GIFT CARD!**

Team
WEST



Ace Monster Toys

Oakland, CA

THE TEAM: Christopher Cook, Hephaestus, Aaron Coats, David Rorex, Rachale Sadd, Ara Jo and Terry Ewing.

Tucked down a side street in Oakland, Ace Monster Toys has a cozy space with some impressive tools, including a full wood shop, a big laser cutter and an even bigger CNC router. The group's interests and activities run from hacking Arduino to sewing, and one night they even get together and talk about math! You can learn more about them here: www.acemonster toys.org.

What is a hackerspace? Learn more and find a hackerspace in your area. Visit www.hackerspaces.org.

BYTE BLASTER

The inspiration for this project came from carnival-style shooting galleries, and the project is themed after the San Francisco Bay area, from where this hackerspace hails. The artwork depicts the Bay Bridge and the skylines of Oakland and San Francisco, and a fog machine provides some added realism. The "gun" is a laser pointer mounted on a repurposed RadioShack soldering iron, which you fire at "sharks" that pop out from behind the waves of the bay. The targets are fitted with photo resistors, which detect hits, and are mounted on servos that move them in and out of sight. An Arduino Mega is the brains of the game; the team programmed it to control the servos, receive input from the photo resistors, trigger sound effects, and tally and display the score. The game measures accuracy as well as the total number of hits, so you need to make sure every shot counts!

One of the team's goals was to design the game in a modular way. The foam core-mounted artwork can easily be swapped out, and other themes can be dreamed up, printed or painted, and mounted onto the game's framework.



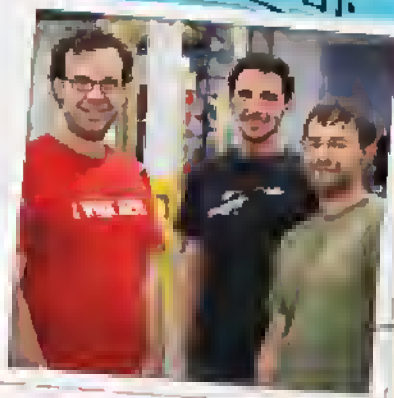
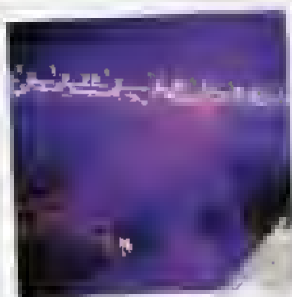
Go online to learn more about these projects and the hackerspaces that built them, view more pictures and videos, and vote for your favorite! The winning team will receive \$1000. And by voting, you'll be entered in a sweepstakes to win a \$1000 RadioShack Gift Card! **Vote at popmechnow.com/radioshack.**

LASER HARP

This enormous laser-stringed harp appears to defy gravity, and in fact, the inspiration for its design came in part from an elegantly designed wine bottle holder that seemingly suspends a bottle in midair. The hackers at Artisan's Asylum built a sturdy torsion box that counterbalances a long arm, onto which twelve laser pointers are mounted. These laser pointers point down to a set of photo resistors, which are connected to an Arduino Mega purchased at RadioShack. To play the harp, the performer sweeps his or her hand through the laser "strings." When a beam is momentarily interrupted, the Arduino sends a message to a connected PC, which plays the note corresponding to that beam. LED lighting effects accompany the musical tones.

Before they arrived at their final design, the team bounced around a few alternate ideas, such as building the harp right into a doorway at their hackerspace so that people of different heights would trigger different notes as they passed through.

The Artisan's Asylum team divided and conquered: one member tested the basic concept by building a single-string prototype, while the others constructed the framework.



Artisan's Asylum Somerville, MA

THE TEAM: Eui Cavalcanti (President of Artisan's Asylum), Mike Soroka, Eric Friedrich, Joe Schlesinger (not pictured)

Artisan's Asylum is a big, bustling hackerspace in Somerville, MA, with an extensive array of fabricating tools. It's full of fun, friendly and creative people, including painters, wood and metal workers, boat-builders and entrepreneurs. You can learn more about the hackerspace at www.artisansasylum.com.

VOTE NOW! View more videos, photos and information about each competing team. VISIT WWW.POPMECHNOW.COM/RADIOSHACK.

DIY TECH

3D components has come way down; the better news is that you might not need anything new at all. If you have a PlayStation 3, a firmware update in 2010 already upgraded your console to play 3D Blu-rays. And it's not even necessary to buy into the Blu-ray ecosystem at all—there are cheaper, easier ways to find 3D video. But you sort of get what you pay for.

3D for Free

If you've purchased a 3D television, it is likely also an Internet-connected, app-enabled "smart TV," a bit of technological overlap that is convenient for the 3D dabbler. Such TVs are available from LG, Samsung, Vizio, Sony, and Panasonic. Internet connectivity opens up some options for viewing 3D content directly from the TV itself with no extra equipment. The home screen of the LG Infinia 47-inch set I recently purchased proudly promises instant access to 3D videos with its 3D World app. The app and its odd assortment of 3D clips are free but require an account registration with LG. The randomness of the 3D offerings seems to defy categorization, yet LG has attempted to construct channels: Japanese pro wrestling is the top selection in Sports, while a 2-minute tour of New York City shot entirely in Times Square is filed under Travel. (There is also at least one bait-and-switch—a listing for *The Mentalist* was not the CBS cop/psychic show but a short clip of a magician performing an act of comically inept levitation.) The shame of the 3D World app is that the footage actually sells the set short—it's not only terrible content, but the stereoscopic effect is awful, routinely giving the viewer double vision.

It's worth mentioning, briefly anyway, that the easiest way to



ACTIVE SHUTTER GLASSES

Active and passive 3D TVs cost about the same, but battery-powered active shutter glasses are heavy and expensive. They do have better off-angle 3D viewing and show fewer jagged-edge artifacts.



PASSIVE POLARIZED GLASSES

Passive glasses are used on sets from LG and Vizio. They are lighter and cheaper. Since the glasses are not as dark, passive sets appear brighter. In our tests, the 3D effect starts to break down when viewed off-center.

experience 3D on any of these sets is by activating the now common 2D-to-3D conversion feature. Most TVs do a pretty good job of discerning foreground from background, but the effect is still a bit uncanny—3D at its best uses depth to add a sense of visual context (think of the difference between the inside of a cramped elevator and the inside of Grand Central Terminal), and the conversion technology seems to make all spaces feel equally deep.

Perhaps the best free 3D delivery vehicle is in hiding on many of these smart sets—YouTube. For three years, YouTube has cultivated a 3D channel for depth-perception enthusiasts. The channel allows users to upload and even edit footage in 3D, then display it in either anaglyph (red and cyan) or a format that conforms to 3D standards that televisions can understand. YouTube has worked with LG, Samsung, and Vizio to ensure that its apps on those manufacturers' HDTVs work, but no one has really promoted it. Much of the content is what you'd expect from a site that relies on the general public for content—3D YouTubers seem to enjoy poking objects into the camera—but often the 3D effect, if not the storytelling, is surprisingly good.

3D Worth Paying For

The most expensive way to experience 3D entertainment on your new set is to buy 3D Blu-rays, and there's no denying that a properly mastered 3D Blu-ray movie or game looks fantastic. Hollywood studios have not yet given up on the concept of premium pricing for 3D movies, but it should provide some comfort that new-release 3D Blu-rays can be purchased on Amazon for far less than their \$40-plus sticker prices. Even cheaper are 3D Imax documentaries, which can be had for less than \$20.

Can't you just rent these things? Not through traditional routes. Netflix and Redbox currently do not stock 3D Blu-rays. But if you're willing to pay high rental prices (typically \$6 for seven days) to an unknown company, 3d-blurayrental.com stocks pretty much every 3D Blu-ray.

The best way to get 3D movies instantly is through Vudu, a streaming service that is built into many sets from LG, Samsung, Panasonic, Vizio, Sharp, and Toshiba. Vudu offers a decent selection of over-the-Internet 3D movies, including big releases such as *Tron: Legacy* and *Mission: Impossible—Ghost Protocol*. Many of the latest hits are for purchase only (although prices are around \$22, which is typically cheaper than 3D Blu-rays). Still, this gives Vudu a bit of an edge over the more dominant players in video streaming such as Apple and Netflix, which have no 3D movie offerings. (Netflix CEO Reed Hastings has promised that 3D streaming is coming shortly.)

Finally, you can get a small selection of content from your television provider. Theoretically, 3D content can be sent for free over the airwaves—in practice, no one is doing that. But cable, satellite, and telcos such as DirecTV, AT&T U-verse, Cablevision, Comcast, and Time Warner offer a limited selection of on-demand content and/or dedicated 3D channels (e.g., ESPN 3D, 3Dnet). Special events, such as NBC's recent coverage of the Olympics, have been shown in 3D, and some service providers offer 3D on-demand movies. This stuff can be a bit tricky, though. I found out that my cable provider, Cablevision, had an entire channel dedicated to 3D content, but when I checked the programming guide, it wasn't there. I contacted Cablevision to ask about the mythical channel 1300 and discovered that it was like a programming ghost ship, coming into existence only on the rare occasions when 3D content is available for broadcast. So if Major League Baseball, for instance, decides to take a game stereoscopic, I've got to get my remote and glasses ready or I just might miss it.





yield unexpected reactions. But don't go nuts: Asking your nephew to pose next to the bear is not okay.

On overcast days or in the shade, (10) **USE YOUR FLASH AS A FILL LIGHT** to illuminate faces. Also, (11) **GET A HOT-SHOE BOUNCE FLASH** if your camera supports it. A bounce flash lets you manipulate light by reflecting it off a ceiling or other bright surface. With a basic point-and-shoot camera, (12) **USE A SHEET OF WHITE PAPER TO DIRECT OR DIFFUSE LIGHT** from a lamp or other source. Speaking of light, (13) **AVOID HAVING YOUR SUBJECT LOOK INTO BRIGHT SUNLIGHT**, unless you like squinty eyes and ugly shadows. If you must shoot in a sunny setting, (14) **LET THE LIGHT FALL AT AN ANGLE** across the person's face. But if you can wait, (15) **SHOOT JUST AFTER SUNRISE OR BEFORE SUNSET**, when the light is softer and the colors warmer.



When snapping pics of kids or pets, (16) **TAKE A KNEE**. Their cute mugs look even better when captured at their own height. Of course, you may also (17) **SHOOT HIGH OR LOW**: Odd angles add drama.

(18) **TAKE YOUR CAMERA EVERYWHERE**—the best photos aren't planned. And always (19) **BRING EXTRA BATTERIES AND MEMORY CARDS**. Having a camera with you that can't do the job is worse than having no camera at all. Now that you're fully equipped, (20) **SHOOT MULTIPLE SHOTS AT A TIME**. The second or third shot—or the fifth one—when your subject begins to relax, can be the best one.

TACTICS

SOLUTIONS FOR EVERYDAY PROBLEMS

20 Ways to Take a Better Photo

BY WOOK KIM

Square-one advice: (1) **GET TO KNOW YOUR CAMERA**. Spending time with the user's manual won't kill you. Some cameras even display tips onscreen while you're shooting, as pop-ups or in help menus. Use the advice; you'll be glad that you did.

(2) KEEP IT CLEAN.

Smudges, specks of dirt, and other schmutz ruin a shot. Stash your camera in a case; buff the lens with a microfiber cloth.

Balanced, centered, gaze-into-the-lens portraits are boring. So (3) **HAVE THE SUBJECT LOOK OFF-FRAME**, and (4) **USE THE RULE OF THIRDS**: Imagine a tic-tac-toe grid within your camera frame and set your subject at one of the intersections. In a head-and-shoulders



shot, align the subject's eyes with the top horizontal line of the (imaginary) grid. Also, (5) **GET UP-CLOSE AND PERSONAL**. Capture one part of the body—eye, mouth, bare shoulder—because details can be telling. You don't need a zoom for this. In fact, we recommend that you

(6) **USE A PRIME LENS**, which has a fixed focal length. With this type of lens, you zoom with your feet (step back or forward) to compose your shot within the frame. A prime lens also often has a low F-stop rating, which lets you (7) **ACHIEVE A SHALLOW DEPTH OF FIELD**. Dial down the F-stop and pull your subject into focus, and the background will blur, creating visual separation. Also regarding backgrounds: (8) **AVOID CLUTTER**. A neutral backdrop keeps the emphasis on the subject. And (9) **PLACE YOUR SUBJECT IN AN UNUSUAL SETTING**. Shots that take people out of their comfort zone

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DIY TECH



Digital Clinic

BY THE EDITORS

ILLUSTRATION BY STEVE SCOTT

Purloined Profile

Help! Someone has hijacked my Facebook account and is posting nasty things about me. How can I regain control and get rid of the embarrassing lies?



Anyone with malicious intent and a little bit of tech savvy has a frightening number of options at his disposal if he is interested in taking over a Facebook account. In 2010 Seattle software engineer Eric Butler developed Firesheep, a Firefox extension that made it easy to hijack unencrypted browsing sessions on a public network. For a time Firesheep made logging in to a social network in a coffee shop or library an open invitation to your private account for anyone who was looking. According to Tim Armstrong, a malware researcher at Kaspersky Lab, Facebook now has default encryption built into its site, which should fend off Firesheepers, but he believes that recent updates to Facebook have opened up other modes of attack. "Facebook changed the layout of the site recently so that it prompts you to reveal where you went to high school, your family members, the town you live in—all this information that is almost a one-to-one with password-reset questions," he says. Armstrong thinks the oversharing that occurs in a typical Facebook profile makes it easy for others to research their

W

WEEKEND

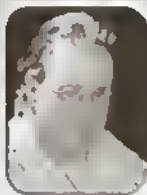
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attains incredible detail, is very easy and cost efficient to operate, and requires little maintenance. The bottom line is: *this machine makes me money!*"

-Jon
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way through the typical questions that are asked by either Facebook or online email providers when you forget your password.

Then again, maybe you just forgot to log out when you used a public computer (another big vector for hijackers). Regardless, once somebody gets into your account, it's a simple matter to change the password and lock you out, then post practically anything under your name. And if that isn't bad enough, there is the potential for collateral damage through Facebook Connect, which uses your Facebook credentials to log in to other sites. So you're going to want to act quickly.

Facebook knows this is a danger and has tools for remediation. The company suggests that anyone who suspects his account has been hacked go to facebook.com/hacked, where users can lock down their account, change the passwords of linked email accounts,

beef up account security, and generally repair any damage. Frederic Wolens, a spokesman for Facebook, calls security an arms race. "Our teams are always working to identify the next threat and build defenses for it," he says. "Most of these defenses are invisible to users, and while malicious actors are constantly attacking the site, what you see is actually a very small percentage of what's attempted." Facebook does, indeed, have a large team dedicated to improving the security of the site, but once you get that account back up and running, we'd still advise heeding Armstrong's warnings about oversharing.

Smartphone Wipeout

I've recently upgraded my smartphone. I want to sell the old one on Craigslist. Do I need to take precautions to ensure that its new owner won't be able to lift any residual personal data?

Smartphones and tablets carry just as much personal data as your computer, and unlike the cellphones of yore, the new devices don't store all the data on SIM cards, which can be removed and destroyed. Unless you want your gadget's new owner browsing through your photos, Web history, text messages, or contacts, you'll need to wipe it clean before selling.

This isn't hard to do—all the major mobile operating systems feature a factory reset option. For iOS devices, head to Settings, then General, and then Reset. Tap Erase All Content and Settings. On Android devices, the reset function is generally under the Privacy menu; for Windows Phone devices, look in the About menu. After a few seconds your smartphone will be void of any personal data.

Keep in mind that when resetting Android and Windows devices, you'll want to remove any micro SD cards (if your device supports them) before selling the phone, since a factory reset doesn't touch removable storage.

App Evaporation

I've downloaded an app for my iPad that Apple has since removed from the App Store. Am I going to lose this the next time I update iOS?

It depends on who yanked the app and how you've backed it up. According to Apple, if a developer pulls its app from the App Store or stops supporting it, then that app will be restored to your iPad or iPhone after you do an OS update. Your purchase will be stored in Apple's iCloud service and, after the update, your iOS device will restore and you'll get the last version of the app before the developer retracted it. If, on the other hand, the app was removed because of a violation of Apple's App Store guidelines, then it will, indeed, disappear when you update iOS.

But it doesn't have to. If you back up your iOS device to your computer via USB, those apps are stored locally on your computer. Apps are files like any other files (if you'd like to reveal their location, you can right-click on any app

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ADVICE
FROM AN
EXPERT



JEFF PEDERSON,
manager of
data recovery
operations,
Kroil Ontrack

WHAT TO DO IF A FLOOD DESTROYS YOUR HARD DRIVE

It's hurricane season, when a wall of rain and water can destroy a home—and your computer, even your backup drive. If you want your data back, you're going to need a pro. Here's what he needs you to know so that he can do his job.

Don't plug in the drive. Don't test it or try to see if it's going to work. You'll only do more damage.

Put it in a plastic bag with a damp paper towel. It may seem counterintuitive, but keeping the drive moist may prevent the read/write heads from sticking to the media.

Check your flood insurance policy. Data recovery for a flooded drive can cost up to \$2000, but some policies have riders that cover data recovery.

in iTunes and select Open Folder in Windows or Show in Finder on a Mac). If you back them up to an external drive, you can always just drag your apps back into iTunes after an iOS update, then sync your device and get your lost app back.

If Apple removed an app that you paid money for and you didn't back it up, the company will usually make you whole again if you submit a claim through iTunes customer service—so don't be bashful about asking for cash back.

Route Around a Router

I recently switched Internet providers, and they gave me a modem with a built-in 802.11b/g Wi-Fi router with one antenna. The thing is, I already have an 802.11n router with three antennas that gives better reception. Is there any way to disable the router from my ISP and use my own?

You can't entirely replace your ISP's router-modem combo, but you can shut down its wireless functionality and use your own router instead. The reason your router is better isn't just reception; it can actually send data faster. Wi-Fi comes in many flavors, and the 802.11 spec tells you a lot about its capabilities. Routers using 802.11 a/b/g are using older, slower technology; 802.11n routers are up to six times faster.

To shut down the ISP's router function, first turn off wireless on your computer and plug into your ISP's device directly with an Ethernet cable. Look on the ISP's modem/router for its IP address—usually something like 192.168.1.1—then type that into a browser on your computer and bring up the ISP device's local Web page. The interfaces between machines vary, but look for a setting that says Turn Off Wireless. Then unplug your computer, hook up your router via the same Ethernet connection, and set it up normally. Finally, turn your computer's Wi-Fi back on again and log in to the network created by your own router. You should be all set. **PopMech**



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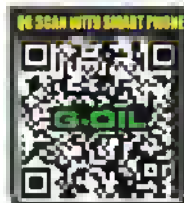


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Adventure



BY MICHAEL FRANK

BEFORE
YOU GO

THE GOODS /
Go for a bone-in 2-inch-thick strip or rib-eye. The bone acts as a heat sink for even cooking.

THE PREP /
Freeze the steak overnight, Fuller says. It will thaw as you hike or paddle in.

THE SEASONING /
Never add seasoning at home. "Salt sucks out moisture, so wait until the last moment," Carmellini says.

THE TOOLS /
Take tongs, not a fork; a small grate or uncoated wire refrigerator shelf; fireproof mitts.

STEAK IN THE WILD

A THICK RIB-EYE TASTES EVEN BETTER SEARED OVER HOT COALS AT THE END OF THE TRAIL.

During college, Michael Fuller guided canoe trips in Ontario's Algonquin Provincial Park. He found himself spending more time planning meals than poring over maps and realized that his real avocation was cooking red meat over hot coals in the woods. "It's all about the smoke, the primal feeling of being in the outdoors," he says. Fuller, now an architect, continues to hone his grilling technique on long paddling trips. These are his tips—with commentary from chef Andrew Carmellini, co-creator of *The Dutch*, a Manhattan chophouse, and co-author with his wife Gwen Hyman of *American Flavor*, a road food-inspired cookbook. Note: Sub charcoal for wood and this advice pertains to backyard grilling, too. **PopMech**



AT THE CAMPSITE

- 1 SET UP THE PIT**
Fuller's system calls for a long fire pit with three sections: a fire area for producing coals; a space to move those coals to, topped by a grill; a cooler section of the grill for slow cooking.
- 2 SEAR THE STEAK**
Cook for a few minutes per side over high heat. Caramelized sugars mixing with fat will provide that classic grilled-steak flavor.
- 3 COOK OVER LOW HEAT**
Move the steak to the cooler side of the grill. In cold weather, cover with foil or a pot lid.
- 4 WAIT BEFORE EATING**
Once it's medium-rare, let the steak rest for 10 minutes off the heat. Then toss it back on to warm up.

W WEEKEND

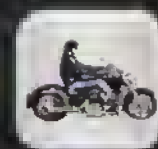
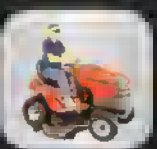
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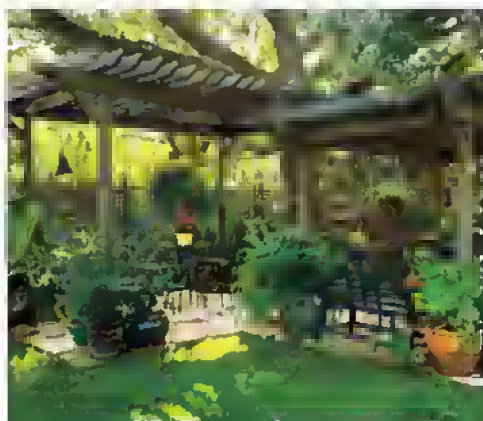
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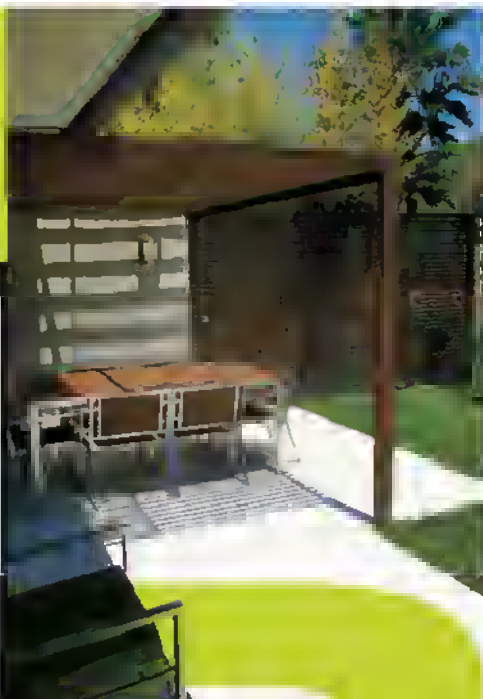
diy

Home

- VACATION-CABIN SECURITY
- EARLY ADOPTER: CATAPULT
- ADIRONDACK-CHAIR WOOD



BY ROY BERENDSOHN



in

WEEKEND

BUILD A PERFECT PERGOLA

REGARDLESS OF SHAPE, SIZE, OR STYLE, NEARLY ALL PERGOLAS REQUIRE JUST A FEW BASIC CARPENTRY SKILLS. BY JOSEPH TRUINI

Pergola plans are an enduring favorite in *POPULAR MECHANICS* (we've been publishing them since the 1920s), and it's easy to see why. The finished product is a blissful addition to any yard, a shady place to sit and read, eat and drink with friends, or zone out on a summer day. From a DIY point of view, the return on investment is high: A small pergola can be built in a weekend and requires reasonably inexpensive materials, plus basic carpentry skills and tools. A simple pergola consists of four parts fastened into a square or rectangle: posts, crossbeams, rafters, and lattice. Here we present eight essential building steps, as well as plans for a pergola to build—or just consider for inspiration. Either way, you win, because a pergola is as enjoyable to make as it is to simply behold.

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8 Basic Steps to Building a Pergola

1

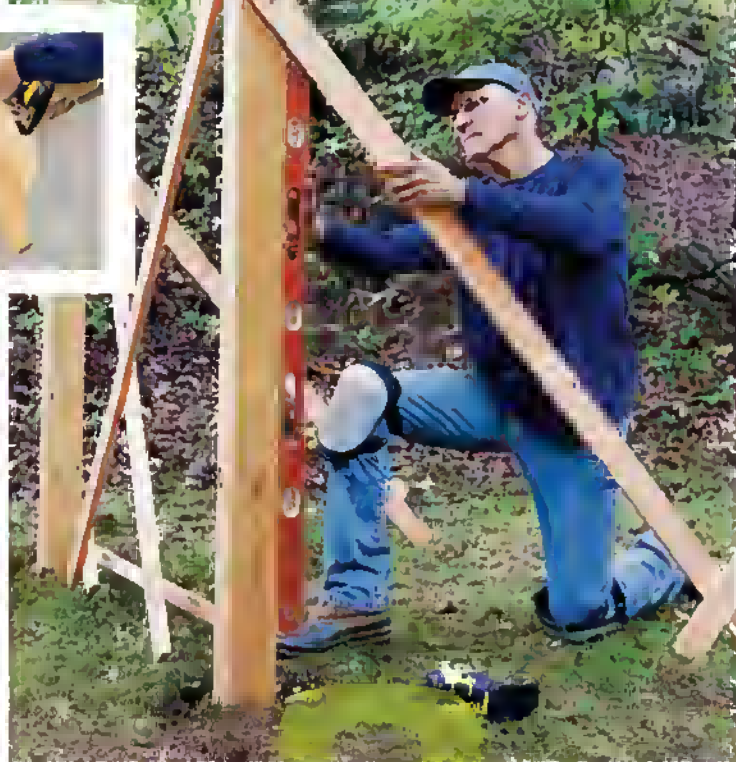
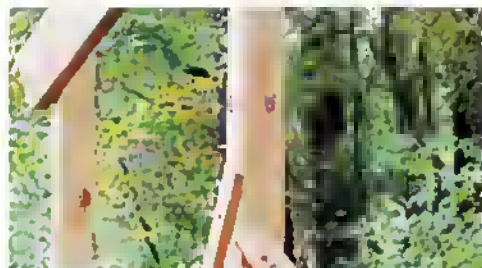


STEP ONE

After cutting the posts, crossbeams, and rafters to dimension, secure one crossbeam to two posts, driving a 4-inch decking screw through the beam into each post. This is a temporary subassembly, so it doesn't pay to get too fussy with it. Just make sure that the top of the beam is nearly equidistant from the top of each post.

STEP TWO

Raise the subassembly, sliding the posts into 18-inch-deep holes. Attach 1 x 3 crossbraces (these are also temporary) to the posts using 1½-inch drywall screws. As you can see in the photo (above, center), the crossbraces are secured alternately to the inside and outside of the posts to increase stability. Next, drive a stake into the ground about 4 feet away from each post. Using a 4-foot level, plumb each post and fasten the braces to the stakes to hold the subassembly in place. Backfill the postholes. Repeat on the opposite subassembly.



3



4



5



screws, then slide the rafter over and repeat the leveling process at the adjacent post. Next, add the remaining two crossbeams.

STEP FOUR

Cut the posts to finished height with a reciprocating saw, using the crossbeams to guide the blade; this ensures a neat, flush cut.

STEP FIVE

Attach each rafter with eight screws. Drive each decking screw at an angle through the rafter face into the top center of each crossbeam.

STEP THREE

Place a 2 x 8 rafter upright on the crossbeams and strap the level atop the rafter with a bungee cord. Loosen the decking screw from the crossbeam to the post, and raise or lower the beam slightly until the rafter is level. Secure the crossbeam to the post with four decking

GLOSSARY

PLUMB

Plumb, the line of gravity, comes from the Latin word for lead, *plumbum* [the lead weight on the end of a string, a plumb bob]. Posts are set in a hole or on a footing and made plumb by checking them on two adjacent surfaces using a level. Lines that are plumb and level are perpendicular.



6



7



8

STEP SIX

Lay the 2 x 4 slats in place and secure them to the rafters with a pair of 3-inch decking screws at both ends of each slat.

STEP SEVEN

The lattice frame consists of two rectangular assemblies with the lattice fastened between them. The frame pieces that face the interior of the pergola are made with 1 x 4 lumber. This frame fits between the posts.

On the exterior frame, the vertical members are 1 x 6s and the horizontal pieces are 1 x 4s. The extra width provided by

STEP EIGHT

Build the flower box and the bench. Level each using a 4-foot level, and attach them to the posts using 4-inch decking screws (and carriage bolts for the bench). Once the pergola's construction is complete, apply two coats of semitransparent stain.

the 1 x 6s creates a flange through which you drive screws to secure the frame to the posts.

To build the frame, crosscut the horizontal frame pieces to match the distance between the posts. Next, crosscut the vertical frame parts to

length. Fasten the lattice frame pieces to each other using 1 1/2-inch decking screws. Finally, place the frame between the posts, check it for level, and fasten the 1 x 6 frame members to the post with 1 1/2-inch decking screws.

WEEKEND

W



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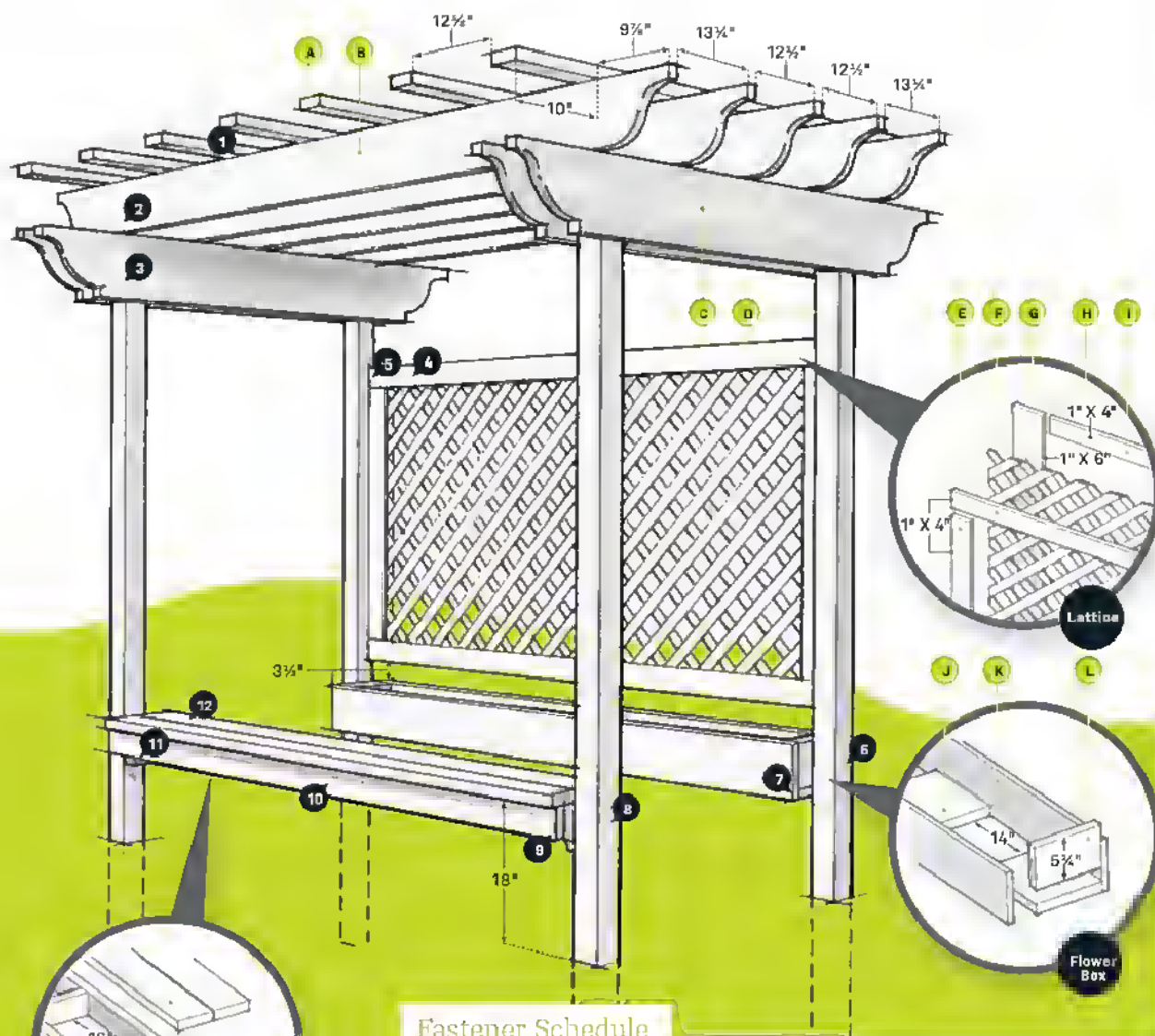
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DIY HOME / PERGOLA



Fastener Schedule

- 1 Slat to rafter: 3-inch decking screws (2 per location)
- 2 Rafter to crossbeam: 2 1/2-inch decking screws (2 per location, per rafter)
- 3 Crossbeams to posts: 4-inch decking screws (4 per location)
- 4 Lattice frame to frame: 1 1/2-inch decking screws (evenly spaced)
- 5 Lattice frame to post: 1 1/2-inch decking screws (evenly spaced)
- 6 Flower-box end to post: 4-inch decking screws (2 per location)
- 7 Flower-box front to flower-box end, supports: 1 1/2-inch decking screws (2 per location)
- 8 Seat to post: 3/4 x 6-inch carriage bolts (2 per location)
- 9 Seat front to seat end: 3-inch decking screws (2 per location)
- 10 Seat front to seat support blocks: 3-inch decking screws (2 per location)
- 11 Seat end to post: 4-inch decking screws (2 per location)
- 12 Seat to seat front/back: 3-inch decking screws (evenly spaced)

Materials List

Part	Qty	Size and description
A	7	2 x 4 x 79 in. (slat)
B	5	2 x 8 x 10 ft (rafter)
C	4	2 x 10 x 79 in. (crossbeam)
D	4	4 x 4 x 10 ft (post)
E	2	1 x 4 x 41 in. (front vertical rail)
F	2	1 x 4 x 90 in. (front horizontal rail)

Part	Qty	Size and description
G	1	48 x 90 in. (lattice panel)
H	2	1 x 6 x 48 in. (back vertical rail)
I	2	1 x 4 x 83 in. (back horizontal rail)
J	4	2 x 10 x 12 in. (flower-box support)
K	2	1 x 8 x 90 in. (flower-box front/back)
L	2	2 x 10 x 5 1/2 in. (flower-box end)

Part	Qty	Size and description
M	2	2 x 6 x 90 in. (seat)
N	4	2 x 4 x 7 in. (seat support)
O	2	2 x 4 x 90 in. (seat front/back)
P	2	2 x 6 x 7 in. (seat end)

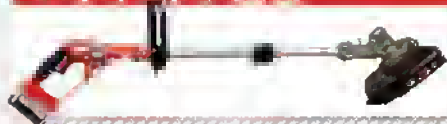
NOTE: All lumber is pressure-treated.

String Trimmers

TOOL TEST

MANUFACTURERS SAY THEIR BATTERY-POWERED STRING TRIMMERS HAVE GAS-ENGINE MUSCLE. TO FIND OUT, WE JOINED THE GROUNDS CREW AT MAKEFIELD HIGHLANDS GOLF CLUB IN YARLEY, PA., AND TRIMMED IN ROUGH AREAS, ALONG FENCES, AND AROUND A POND. BY ROY BERENDSOHN

BLACK & DECKER LST136



RANKING ★★★★★

PRICE: \$170
VOLTAGE: 36
WEIGHT: 7.8 LB
CUT WIDTH: 13 IN.

LIKES: Every electric trimmer could use the feature that helps this product excel: a Power Command dial that lets you adjust power from 1 to 6. The 1 setting is for maximum run time; 6 gives maximum power. The cut quality is superb at any setting. **DISLIKES:** None noted.

CORE CGT400

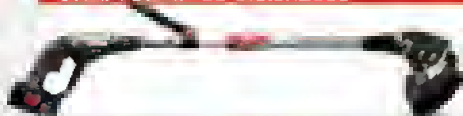


RANKING ★★★★★

PRICE: \$288
VOLTAGE: 21
WEIGHT: 11 LB
CUT WIDTH: 14 IN.

LIKES: Smooth-cutting and powerful, the Core looks and feels like a gas-engine trimmer, but it's blissfully quiet. **DISLIKES:** We experienced line-feeding problems. Core said our tool was a pre-production model and that the problem has been fixed with a new line feed and cutoff system.

CRAFTSMAN C3 315.CR2000

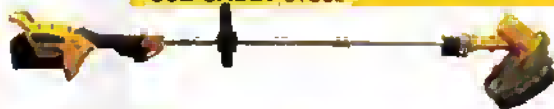


RANKING ★★★★★

PRICE: \$135
VOLTAGE: 19.2
WEIGHT: 7.3 LB
CUT WIDTH: 12 IN.

LIKES: Rubberized grip surfaces plus excellent adjustability of head and handle angles and shaft length make the Craftsman comfortable to operate. **DISLIKES:** Needs a stiffer or thicker line for more aggressive cutting.

CUB CADET ST59L



RANKING ★★★★★

PRICE: \$178
VOLTAGE: 20
WEIGHT: 8.2 LB
CUT WIDTH: 12 IN.

LIKES: With a 40-minute run time in a mixture of short grass, tall grass, and knee-high weeds, this tool shows stamina. **DISLIKES:** Better trigger and handle geometry would make the Cub Cadet less tiring to use.

RYOBI RY24200

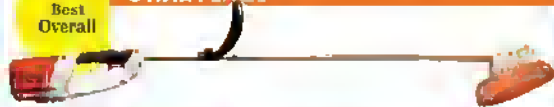


RANKING ★★★★★

PRICE: \$140
VOLTAGE: 24
WEIGHT: 8.15 LB
CUT WIDTH: 13 IN.

LIKES: Top-notch combination of light weight, aggressive power, and adjustability. **DISLIKES:** The small plastic wheel intended to allow the trimmer to be used vertically along sidewalks is ineffective; better to just ignore it and hold the trimmer vertically.

STIHL FSA 85



RANKING ★★★★★

PRICE: \$468
VOLTAGE: 36
WEIGHT: 8.7 LB
CUT WIDTH: 14 IN.

LIKES: With enough power for commercial work, the Stihl slices through grass, tall grass, and knee-deep weeds. It's the only trimmer capable of reliably cutting briars with a 3/8-inch-diameter stalk. **DISLIKES:** None noted.

TROY-BILT TB60 AF



RANKING ★★★★★

PRICE: \$290
VOLTAGE: 28
WEIGHT: 9.12 LB
CUT WIDTH: 14 IN.

LIKES: If you hate dealing with trimmer string, this is your machine. It's equipped with four flexible plastic blades that can be installed or replaced in minutes. They cut grass effectively yet gently. If you accidentally hit a tree trunk, you won't strip its bark. **DISLIKES:** None noted.

* ALL WEIGHTS INCLUDE BATTERY

HOME EDITOR ROY BERENDSOHN ON TESTING STRING TRIMMERS

We learned two things: Makefield Highlands Golf Club has a gorgeous course, and any one of these trimmers can handle a typical yard. Two of them would satisfy even a pro landscaper.

DIY HOME



Ada Talbert, 7,
of Los Angeles
takes dead aim.

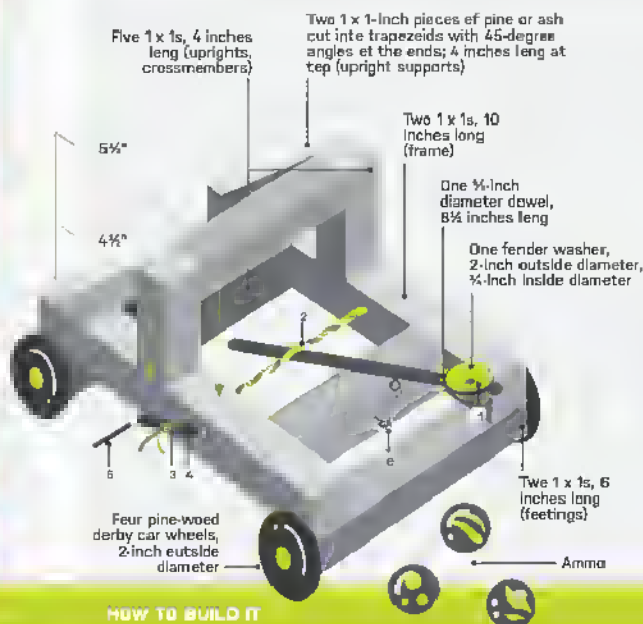
EARLY ADDPTEP

Onager Catapult

THIS PROJECTILE-HURLING MODEL OF THE ANCIENT ROMAN WEAPON PACKS A WALLOP. ENJOY BUILDING IT WITH YOUR KIDS—BUT MAKE SURE THEY DON'T AIM IT AT THE FAMILY DOG.

— ADAPTED FROM BACKYARD BALLISTICS BY WILLIAM GURSTELLE

Parts and Supplies



HOW TO BUILD IT

Make the catapult frame

1. Drill four $\frac{1}{16}$ -inch pilot holes through the 10-inch frame pieces, with the holes $\frac{1}{4}$ inches from each of the four ends and centered vertically.
2. Drill a pilot hole into the center of each end of the crossmembers.
3. Apply glue to the ends of one crossmember and near the pilot holes on the inside of the 10-inch frame pieces; screw the crossmember into place. Repeat this step on the other end.
4. Drill $\frac{3}{16}$ - and $\frac{1}{8}$ -inch holes through the sides of the frame, 5 inches and $5\frac{1}{2}$ inches on center, respectively, from the front of the frame.
5. Glue the footings to the bottom of the frame, flush with the sides and 1 inch on center from the ends. Drill pilot holes into the center of the ends of the footings; screw the wheels into place.

Install the uprights and upright supports

6. Using the drill-glue-and-screw process, secure the uprights to the frame. The uprights should be $4\frac{1}{2}$ inches on center from the end, the screws driven in from beneath the frame.
7. Drill, glue, and screw a crossbeam flush with the tops of the uprights.
8. Drill, glue, and screw the supports into position.

Make the throwing arm

9. Drill a $\frac{1}{4}$ -inch hole through the center of the long dowel about $\frac{1}{4}$ inch from the end.
10. Use the round face of the hammer to shape the washer into a cup.
11. Attach the washer to the dowel (the cup's rim faces up) using the bolt, lock washer, and nut.

Manual saw and miter box

Ball-peen hammer

Yellow wood glue

18 No. 6 wood screws,
1½ inches long

Power drill with ¼-in., ⅜-in.,
and ½-in. bits

- 1 One No. 10 bolt, ¾ inches,
with nut and lock washer
- 2 One 36-inch length of
18-pound nylon cord
- 3 Two ¾-inch washers,
¾-inch outside diameter,
¼-inch inside diameter
- 4 Two ¾-inch-diameter
dowels, 1½ inches long
- 5 One ¾-inch-diameter
dowel, 1½ inches long
- 6 One small eyebolt and
anchor

Assemble the torsion spring

12. Fold the nylon cord in half twice; tie the loose ends with a square knot.
13. Feed the folded cord through the ¾-inch holes, leaving ½ inch of cord on the outside of the frame. Place a washer over each bundle of cord.
14. Insert the ¾-inch dowels into the cord loops; position the throwing arm in the middle of the cord.
15. Rotate the dowels toward the front of the frame until the arm presses against the crossbeam. Insert the ¾-inch dowel into the smaller hole.
16. Lower the throwing arm down to the frame. Mark spots on the frame and arm where the anchor and eyebolt will be screwed in.
17. Increase the cord's tension by turning the dowels forward. Lower the arm, hook it into position, and remove the locks.
18. To fire the catapult, load the bucket with a projectile and carefully push the anchor hook out of the eyebolt.
19. Reload and repeat to your heart's content!

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Home Clinic

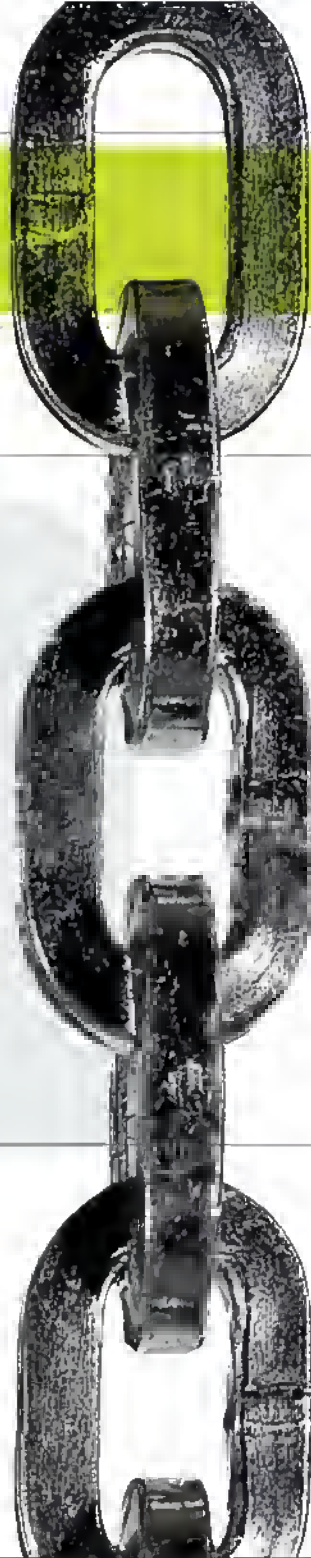
BY
ROY BERENDSOHN

PHOTOGRAPHS BY
SAM KAPLAN

Lockdown

I've got a vacation cabin, and for the first time we've had repeated break-ins and some theft. To increase security, I was thinking of chaining a few valuables down. Is there a chain that can't be cut with bolt cutters?

The short answer is yes, you can get cut-resistant chain (shown above). It's hardened throughout its thickness, and its flat face distributes the force of the bolt cutter's jaw over a wide area, thereby diffusing it. There are also industrial high-strength welded steel chains that are through-hardened. The larger diameters of these chains, especially the 5/8-, 3/4-, and 1-inch sizes, are extremely difficult to cut due to their girth and hardness. (Note I say difficult, not impossible; there are



W

WEEKEND

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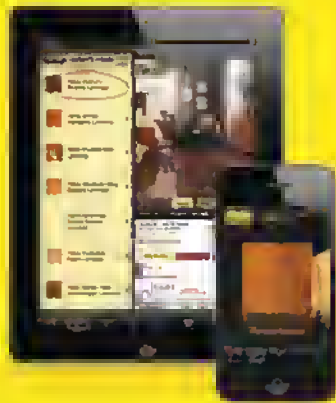
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Room Designer

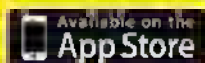
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DIY HOME / HOME CLINIC

industrial bolt cutters that have jaw sizes as large as $\frac{3}{4}$ inch and are designed to cut hardened steel.) Industrial chain is rated by grades; the higher the grade number, the more steel alloying elements it contains and the more resistant it is to the variety of loads a chain encounters, especially in tension. Grades 70, 80, and 100 are among the hardest and toughest available. Here's the kicker, though. We're talking chain that costs \$10 to \$22 per foot; it's likely to be more valuable than what you're chaining down, a fact that might not be lost on an enterprising thief, who might just make off with the chain itself.

Regardless of how strong the chain is, you'd also need a cut-resistant padlock, such as a shrouded model by Master Lock or Sobo. You might also have to attach the chain to something secure, such as a concrete footing. Likewise, hasps, bars, and bolts have to be thick and impregnable. It doesn't take much to deter a lazy thief, but it takes a lot to keep out one who's determined to get in, if for no other reason than to prove his point. Any weak link (if you'll excuse the pun) invites trouble in the form of a bolt cutter, an oversize crowbar, or—don't laugh—a chain hooked to a large pickup truck. I had a neighbor whose home was burglarized by a thief who used the rear bumper of his pickup truck as a battering ram, which he put through the front door.

I might be stating the obvious here, but cabin owners have relied on some pretty low-tech security measures over the years. First, make friends with local families and fellow cabin owners. In all but a few communities, people look out for one another. Next, don't store anything in the cabin or an outbuilding that you'd be afraid to lose. Keep power tools, chain saws, outboard motors, or other gear elsewhere. There may be a local business that can store equipment for you for a fee, or a nearby storage facility. Sure, stopping on the way to the cabin is a nuisance, but so is having your property stolen.

Finally, alert the local authorities when you're away. Some rural police departments have added four-wheel-drive vehicles, snow sleds, and ATVs to their fleet, making it possible for them to patrol remote areas.

Cracks: When to Worry

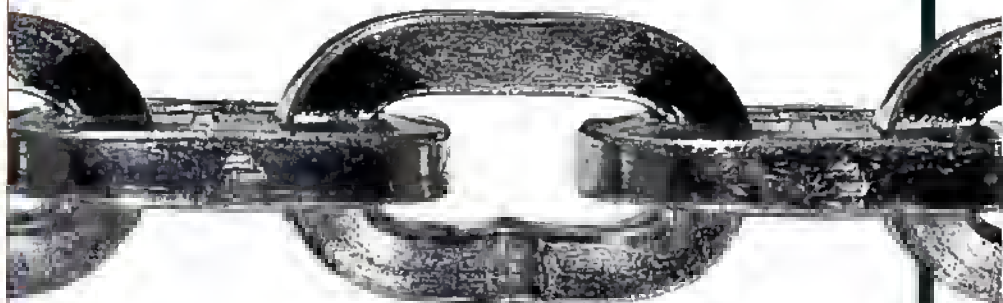
We have a crack in our foundation wall. Do we need to be concerned about it structurally? And could termites enter through it?

Put it this way: A crack doesn't have to create structural troubles for it to be a problem. Cracks are ugly, suspicious things that aren't easy to fix, and even one that's no more than a hairline could grow and create all kinds of difficulties.

I would say any crack wider than $\frac{1}{8}$ inch is a problem, especially if it admits water or increases in width or length, or if its faces grind against each other with changes in temperature and humidity. All of these indicate foundation movement—and that's not good.

As for termites, those pests can slip through a crack that's $\frac{1}{8}$ inch wide. If you live in an area where termites are common, have your home inspected by a licensed termite-control contractor.

The good news is that in most cases only large cracks indicate structural





trouble. You'll need to contact a structural engineer or foundation repair company if the crack wraps around a corner, reaches from the basement floor to the top of the foundation wall, or runs horizontally and the wall below it leans into the basement. All of these problems indicate that the soil supporting the foundation is moving (horizontally or vertically) and taking the foundation with it.

It's tough to fix a crack. It's one thing to simply fill it with epoxy and hope that it holds. It's a much larger matter to evaluate the foundation inside and out and determine what's causing the crack, undertake those repairs, and then seal the crack shut for good. That kind of repair is expensive and often involves reducing the hydraulic forces acting on the foundation by installing drainage pipes, gravel, filter fabric, a sump pit, and a pump. In the worst cases, the foundation may need additional support from piers driven next to it. It takes an experienced foundation repair company to do that work.

If you're going to attempt a DIY repair, do your homework. A number of sites offer small-scale versions of epoxy injection kits used by contractors, and you can still buy tried-and-true cement-based products such as those made by Thoro (thoroproducts.com).

Adirondack Options

I've checked out your cedar Adirondack chair plans online and would like to know what other kinds of wood I can use.

The nice thing about Adirondack chairs is that you can build them out of nearly any wood. Redwood and cypress are easy to work with and highly weather resistant, especially if stained or coated with a clear preservative. I've even seen these chairs built out of white pine—with pine, though, you should pretreat the wood with a paintable water-repellent preservative that also provides protection against wood-boring insects. (Woodlife CopperCoat is a good choice.) And when using pine, be particularly careful to soak the end grain to reduce the chairs' tendency to wick moisture from the ground or a wet surface. I'd follow the pretreatment with a quality alkyd primer and topcoat paint or an exterior alkyd wood stain.

Another option is pressure-treated lumber. With that material, you wind up with a chunky, lumberyard look that some people really like. Let the wood dry thoroughly before using the chairs, to avoid any chance of skin irritation from the treatment chemicals (especially important with kids). You should use hot-dipped galvanized or stainless-steel fasteners with any outdoor woodworking project, but they're essential with pressure-treated lumber, which aggressively attacks steel fasteners, causing them to corrode. **PopMech**



**GOT A HOME-MAINTENANCE OR REPAIR PROBLEM?
ASK ROY ABOUT IT.**

Send your questions to pmhomeclinic@hearst.com or to Home Clinic, Popular Mechanics, 300 W. 57th St., New York, NY 10019-5899. While we cannot answer questions individually, problems of general interest will be discussed in the column.



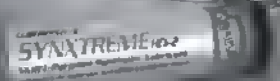
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Science



BY ADAM HADHAZY

**STAR CHART**

Choose a printed map or an app with a red-light mode, such as GoSkyWatch.

INOCULARS AND MONOPOD

Use 10x50 binoculars or, to hunt for less luminous objects, 15x70. To support and swivel them during sustained stargazing, a monopod is helpful.

GUIDE WHAT TO TAKE

BUG SPRAY
Nothing spoils a great night of observation faster than mosquitoes.



LAYERS
It may be summer, but nighttime temps and dewy grass chill.



FLASHLIGHT
Red light only: It preserves night vision. (White light from a cell-phone kills it.)



CAMP CHAIR
Avoid neck strain by leaning back in an adjustable camp chair.

STARGAZING MADE SIMPLE

Binoculars don't just bring birds into focus—they're a cheap, portable tool for zooming in on the night sky too. The handheld lenses let you examine a wide field of view, right side up and with both eyes, unlike most backyard telescopes. Robin Scagell, co-author of *Stargazing With Binoculars*, advises setting up shop a mile from well-lit areas. "Avoid looking at bright lights before you go out," he says. "And give yourself 20 minutes to let your eyes adapt to the darkness."

Start by checking out craters in the nearly full moon, which in the U.S. will be in the southeastern portion of the night sky in early August. Then look for Mars and Saturn hugging the horizon to the southwest. Pick up the trail of the Milky Way arcing overhead, and follow it to features such as the Butterfly Cluster and Eagle Nebula. To spot fainter objects, such as the Andromeda Galaxy, wait until the moon wanes. Scagell also suggests relying on more sensitive peripheral vision: Gaze to the side rather than directly at where an object is located. As mid-night approaches on Aug. 11 and 12, set down the binoculars and face south to take in the fast bright streaks of the Perseids meteor shower. **PopMech**

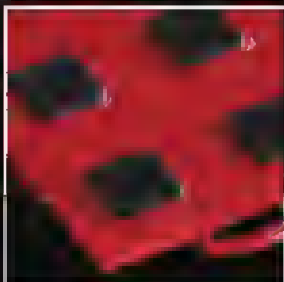
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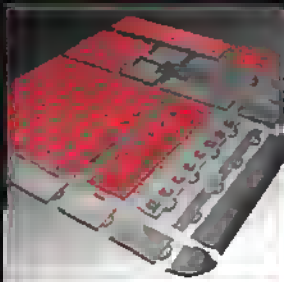
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Auto

• BATTERY WORRIES
• WHAT A DRAG



DEGREE OF DIFFICULTY **4/10**

BY BEN WOJDYLA

GLASS WARFARE

PETTY AUTO THEFT OFTEN MEANS BROKEN SIDE GLASS. REPAIRING THE DAMAGE YOURSELF IS ONE WAY TO EASE THE LOSS.

Y

ou get a pretty nasty knot in your stomach when you discover your vehicle's side window has been smashed and the interior ransacked—ask me how I know. On top of whatever was taken, there's the added injury of getting the car repaired. Between the time it requires to file a claim with the insurance company and the inconvenience of taking the car to the shop, fixing the window yourself can sometimes save a lot of headaches. Professional glass repair, including new glass and labor, has a frustrating tendency to cost exactly a few dollars less than an insurance deductible, so doing it yourself can save a ton of money. With a few pointers and some savvy parts sourcing, that unprotected hole in the door can be fixed in no time.

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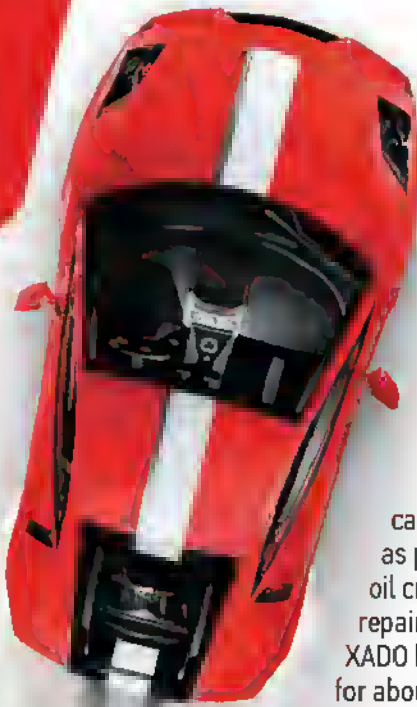
SMART

WHAT MAKES CARS GET OLD

Engine wear due to friction makes cars feel sluggish and old over time. When you start your car in the morning metal grinds against metal because all of the oil that is supposed to be lubricating your car's engine has drained into the oil pan while your car was not in use. What makes matters worse is that even the best motor oil needs to warm up to become useful, and it typically takes about 30 minutes for oil to reach its optimal temperature.

HOW CAN THIS ENGINE WEAR BE PREVENTED?

By treating your car's engine and transmission with XADO Revitalizant you can reverse prior wear, and prevent future wear. XADO Revitalizant is a smart, self-regulating nanotechnology that rebuilds metal and coats it with a layer of ceramic-metal. Having a ceramic-metal coating inside your engine decreases friction during startup and operation. This reduces engine wear and prolongs your



car's life. Applying the product is as easy as pouring the contents into your engine oil crank case, which means no mechanical repair or downtime is required.

XADO has been selling Revitalizant in Europe for about 15 years, so the technology is tried and true.

WHAT HAPPENS IF YOU ADD TOO MUCH?

XADO Revitalizant is self-regulating, meaning it is formulated to stop bonding after it has reached its maximum thickness. Any excess simply continues safely circulating through your engine oil.



HOW DOES XADO REVITALIZANT REALLY WORK?

When you add Revitalizant to your car's engine or transmission Revitalizant uses the friction in your car to repair scratches, gouges and wear and simultaneously form a diamond-hard protective coating. This coating is 10x stronger than steel and lasts for 60,000 miles!

A BRAND NEW CAR CAN LOSE ABOUT 3 GRAMS OF METAL DURING ITS BREAK IN PERIOD, AND A LOSS OF ONLY 60 GRAMS IS CONSIDERED CRITICAL ENGINE WEAR. REVITALIZANT MOLECULES, WHEN ACTIVATED BY HIGH FRICTION ACTUALLY REBUILD WORN METAL AND REPLACE IT WITH A SEMI-PERMANENT LAYER OF CERAMIC-METAL TO ELIMINATE FRICTION AND PREVENT FUTURE WEAR.

REVITALIZED CAR UNITS LAST



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HOW IS XADO REVITALIZANT DIFFERENT FROM OIL ADDITIVES?

Most oil additives consist of heavy oil mixed with microscopic particles of plastic (PTFE). The problem is these particles settle everywhere—in filters, oil lines, and other places they should not be. This can be dangerous for your car.

XADO Revitalizant treats metal—not oil. It only works where there is enough friction to activate it. So it works where it is needed without interfering with oil lines and filters.

XADO's self-regulating nano-technology does not cake, flake or clog.



1STAGE MAXIMUM ATOMIC METAL CONDITIONER

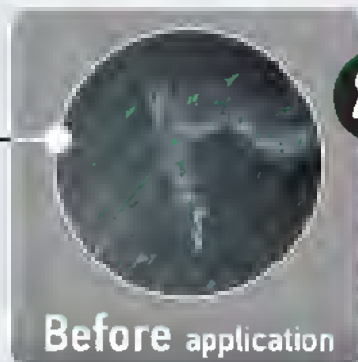
Just 1 bottle contains enough Revitalizant to fill in scratches, gouges, and wear in your engine and protect your car from future wear for 60,000 miles.



REVITALIZATION IS SO EFFECTIVE YOU CAN ACTUALLY SEE THE DIFFERENCE

A damaged bearing was treated with XADO Revitalizant. The scratched surface is turned into a smooth, glossy surface free of defects.

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Clean Up

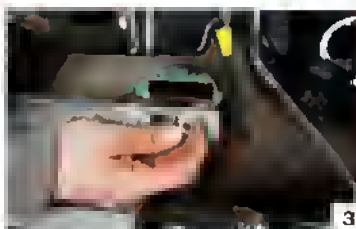
Unlike plate glass, auto glass is tempered, or heat treated, so it's very hard, but when stressed past its breaking point it fails uniformly and catastrophically. This results in small pieces that won't cause grievous harm to passengers, but the debris gets everywhere and will result in tiny, annoying cuts. Grab a powerful shop vacuum and clean the seats, doors, dash, carpet, and center console. Do the entire interior even if it doesn't seem necessary; glass will be in places that don't make any sense. Safety glasses and good work gloves are a must.

Getting Parts

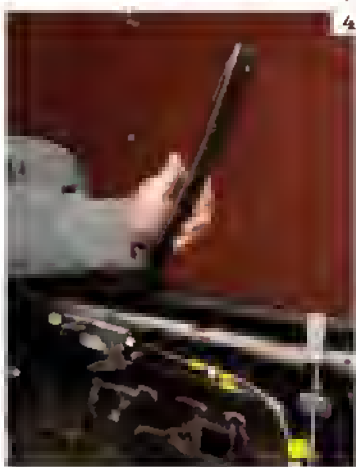
If you drive a luxury car with acoustic panes and special coatings, new glass is crazy expensive and hard to find. Mass-market cars have more affordable and readily available parts. Most auto dealers will refer you to a glass specialist for brand-new parts, but if you can locate used glass, the savings can be significant. Hunt through nearby junkyards to find parts for common vehicles at steep discounts. For my 2001 Ford F-150, shown here, used glass cost 11 percent of a new piece—\$18 from a local yard versus \$160 from a retailer.



1 →

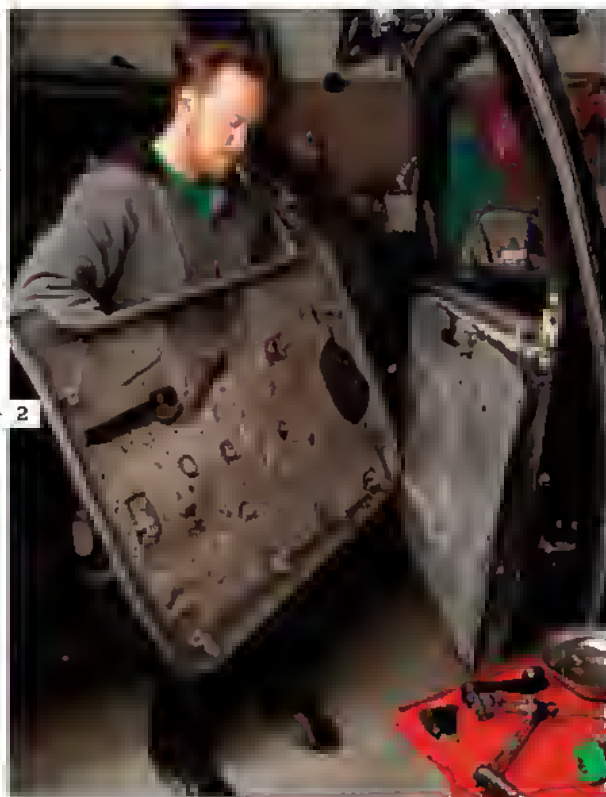


3 ← 2



↓

4



[1] To remove the inner door panel, look for nuts and bolts hidden behind trim. [2] The door panel is usually one big piece with components such as armrests bolted on. [3] Loosen the screws on the regulator to free the leftovers. [4] Pull the lower window seal, making a wider slot to slide the new panel in.

Behind Door No. 1

The basic steps for replacing door glass are common, but the devil is in the details. The inner door panel comes off, the mounting hardware holding on to broken shards must be extracted, and new glass has to be shimmed into place; then everything's got to be bolted back together. My truck is very basic—power nothing with roll-up windows—but as cars get more complicated, inner door panels get more devious in design. Grab a service manual for your car to make the process much clearer. This door panel on my F-150 is one big piece of plastic hung on retainer hooks, held tight by a few screws hidden behind trim. Yours will definitely be a harder repair, with multiple layered components and finicky clips. If you have power windows, and most late-model cars do, you'll need to unhook the quick-disconnect plug that

QUICK TIPS

→ Interior designers work hard to hide the screws and clips holding the door together, so peek under and behind places you wouldn't normally look.

→ Tools you'll need include screwdrivers and a socket set, but a trim-removal tool will help a lot. It makes popping off clips and retainers much easier than with a screwdriver.

→ Since we're dealing with glass, wear a heavy long-sleeve shirt, full pants, covered shoes, gloves, and safety glasses. Tempered glass is safer than plate, but still treat it with respect.

→ When handling glass, be very methodical and don't force anything. If getting something to fit is too hard, you're not doing it right. Step back and examine the situation again.

→ Take pictures in sequence to remember how everything goes together. Keep removed parts in a cup or on a tray so they don't get lost.

W

WEEKEND

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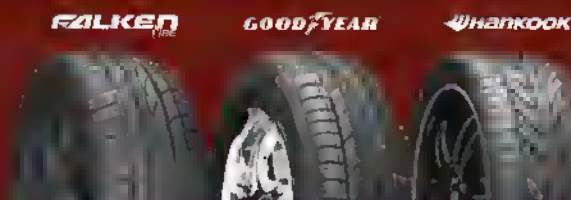
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delivers power to and from the window switches mounted to the inner door panel.

Remove and Replace

With the inner door panel removed, peel back the plastic vapor-barrier sheet carefully, as you will need to reinstall it later. You should be able to see the door's innards. Raise or lower the window-height-regulator mechanism to its service position—a height where the bolts or screws holding the glass remnants to the regulator align with access holes stamped in the steel. Crank windows make this easy; on power windows, plug in the switches on the loose inner door panel and turn the ignition to the "on" position; operate the window until the bolts align with the access holes.

See the full installation on YouTube.

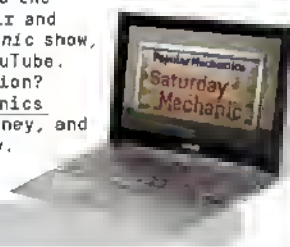


Vacuum broken glass from the door cavity; spending extra time here now avoids rattles later.

Next, remove the seal at the bottom of the window to open up the slot the glass panel needs to fit through. Finally, free one of the window tracks for fore-and-aft play that will make the install easier. These tracks guide the panel's path and are bolted along the bottom of the door.

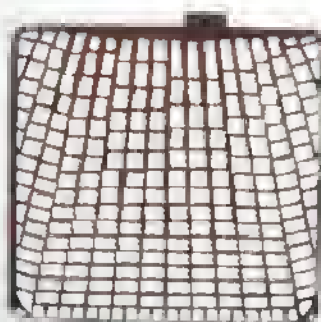
Wiggling the new glass into place is tricky. Drop the shorter side in first at a near-90-degree angle and try to catch the long side of the glass in its track, then rotate the short side up. After a few tries the glass will slip into place. Attach the glass panel to the regulator (ask a friend for help) and bolt the window track down, then run the new glass up and down to ensure that the motion is satisfactory. The remainder of the work: Put the door together in reverse order. Hopefully you took good photos.

DIY CAR CARE: BEN BOWMAN takes to the really small screen to demonstrate this repair and other fixes and upgrades on the *Saturday Mechanic* show, presented by the Car and Driver Channel on YouTube. Want to get in on the Internet automotive action? Submit car-related questions to popularmechanics.com/cdchannel, and Ben may save you time, money, and needless frustration when your ride goes awry.



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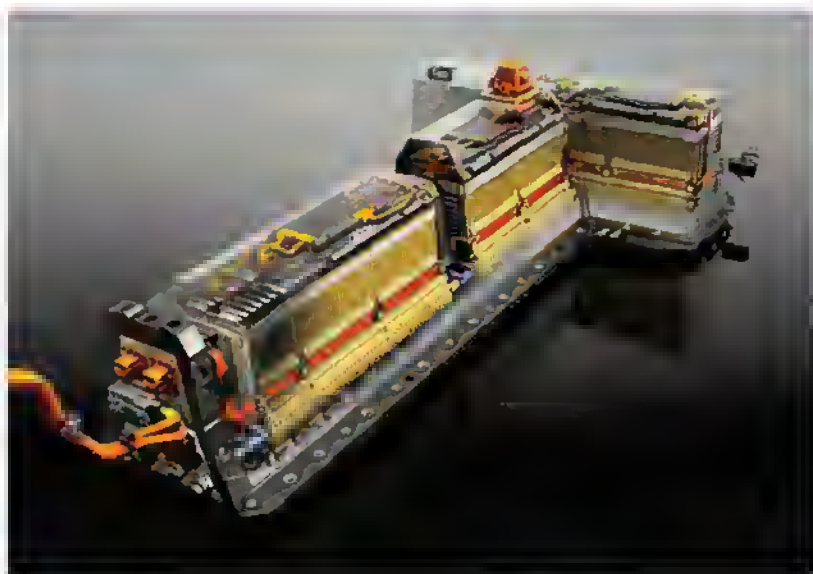
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Car Clinic



BY
BEN WOJDYLA

Volt Vindicated

I've been thinking about buying a Chevy Volt, but the news stories about battery fires have freaked me out. Can you supply a definitive answer about what's going on?

Of the 15,054 Chevy Volts sold as of this printing, exactly zero have caught fire out in the real world. I don't want to sound like a cheerleader for the Volt program, but it pushed a lot of boundaries in engineering and testing and in some ways exceeded the standard testing parameters the National Highway Traffic Safety Administration (NHTSA) uses. All the hubbub centers around one particularly strenuous crash test—the side pole test—done in May 2011. In this series of tests, a car is run sideways into an immovable steel post at 20 mph, then it's rolled 90 degrees onto its side and all the fluids are allowed to leak for 5 minutes. The car is then rolled onto its roof for 5 minutes and then onto its other side. The test looks for side intrusion into the cabin and damage or danger caused by the loss of car fluids. NHTSA's Volt passed these tests and was parked in an outside storage area. A strange thing happened: After three weeks, the battery

The Chevy Volt's T-shaped battery pack includes more than 200 lithium-ion cells, a coolant-circulation system, and electronics. It also acts as a structural element.

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DIY AUTO / CAR CLINIC

GLOSSARY

ETHYLENE GLYCOL

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caught fire, consuming the already wrecked vehicle and a few cars nearby.

I spoke with Doug Parks, GM's global vehicle chief engineer for the Volt, who started off by saying, "I believe the Volt has always been safe, but this was an event we needed to investigate thoroughly." After some sleuthing, they found the source of the fire was a short circuit caused by something called dendritic growth. The phenomenon occurs when energized silicon chips get wet and their metals are leached through the substrate, growing into what looks like tree roots that eventually lead to a short circuit. The battery in the Volt is shaped like a capital T, with the top of the T under the rear seats and the remainder running up the center tunnel between the front seats. During the test the undercarriage crash structure successfully absorbed crash energy but also punctured the battery case and cooling system. When the car was rotated, coolant worked its way onto the top of the battery, where a major control module lives, and got its silicon chips wet. Because the testing standards at the time did not require the battery to be discharged after the crash (analogous to draining the gas tank, which is standard practice), dendritic growth occurred and the chip short-circuited, connecting the poles of the battery and leading to a battery fire.

After repeated testing to replicate the scenario, GM found the probability of this happening in a real-life crash to be nearly zero but took preventive action anyway. The area of the battery tunnel around the crash beam was reinforced, and a coolant-leak sensor was added as well. All new Volts built since February come with these upgrades, and older cars can be taken in to dealers for what GM calls enhancements, since this isn't considered an official recall. Parks also noted, "The major automakers including GM are now working with the Society of Automotive Engineers to standardize discharge methods following an impact event." I've paid close attention to this story, and after reviewing the testing, failure mode, and response, I'm comfortable with the performance of the Volt in crash testing. As a final thought, consider this: Traditional cars tote around 15 gallons of highly flammable (and carcinogenic) gasoline in an easily pierced tank under the car, yet you don't even think about it.

A Day at the Drags

I have a 1986 Chevrolet Camaro that is a daily driver for me. I want to take it occasionally to the dragstrip, and I'd like to put drag radials on the car. The original tire size is 215/65R15, and the drag radials are 235/60R15. A little math reveals that the drag tires will rotate three fewer revolutions in a mile (773) than the stock tires (776). I'd like to know how much this will affect my speedometer.

You've picked just about the perfect car for this kind of thing. Camaros and Mustangs

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were practically built for the strip, and aftermarket parts are so plentiful you can almost build the car from scratch. Your choice to go with drag radials for racing is a wise one; these tires have much better grip than standard tires, owing to a softer rubber compound. Great for racing, bad for daily driving. The drag radials are slightly larger in diameter, which will have a tiny effect on the accuracy of your speedometer, and you've already done the hard calculations to figure out how much. The revolutions per mile of the drag tires are a percentage of the original tires' and thus will result in a speedometer reading lower by the same percentage. How much? Divide the stocks' revs per mile (776) by those of the drag radials (773). That gets you to 1.0038, the amount to multiply to figure out the true speed. For example, with the drag radials installed and the speedo reading 70 mph, multiply by 1.0038 to get 70.27 mph. The error at 70 mph is a scant 0.27 mph. Here's the catch to all of this: Your speedometer isn't accurate anyway. Unless you're driving an ex-police-spec car with a calibrated speedometer, your factory speedo is off by as much as 5 percent even when new. That's much more than the difference your new tires will make. The takeaway? Just run it at the strip for fun and don't worry about the speedometer's accuracy—that's what the timing lights are for! **PopMech**

WEEKEND

W

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**GET A CAR PROBLEM?
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Send your questions to pmautoclinic@hearst.com or over Twitter at twitter.com/PopMechAuto or to Car Clinic, Popular Mechanics, 300 W. 57th St., New York, NY 10019-5899. While we can't answer questions individually, problems of general interest will be discussed in the column.

on interior posts, which won't help in an earthquake. The bolts could crack the wood like a log splitter, Sylvis says; newer jobs use clamp-like bolting instead. The plywood that lines the cripple wall, which transfers strength from the foundation to the floor, is 3-ply, whereas 5-ply is required in permitted jobs. More concerning, the wall doesn't fully reach the floor. A nail gun was used to secure the plywood to the framing and the nailheads are recessed, increasing the likelihood that the nails would rip through the wood during a tremor. "It looks like a responsible contractor did it," Sylvis says. "But that doesn't mean he did a good job." Is it enough? I ask. His answer sounds all too familiar: "It's a lot better than nothing."

It will cost roughly \$6000 to rebolt the house, so that upgrade remains on our to-do list for now. But in most ways we've become well-prepared—especially compared with many Californians. When a violent windstorm knocked out power last December, Dan, Otto, and I were in good shape. We had lanterns and headlights, batteries, an adapter to charge our phones in the car—and Twitter accounts, which proved to be the best way to get information. While friends' panicky Facebook posts talked of evacuating to the Valley or West Side beach communities, Dan was uploading cute pics of Otto eating canned ravioli by lantern light. What if the freeways were closed, I wondered. The supermarkets shut down. ATMs out of service. This windstorm was nothing when stacked up against what a big quake could deliver.

"We live in a world that has things we don't understand very well," Heaton says. "Does that mean we throw up our hands and just say it's inevitable, that we're going to die anyway?" No. It means we design buildings to make them less vulnerable. We prepare our homes and families to ride out calamities. And we take comfort in the fact that by preparing for the worst, we can maximize the chances that when disaster comes we'll be among those ready to offer help, rather than those who need it. **PopMech**

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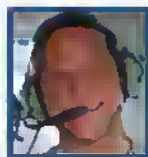
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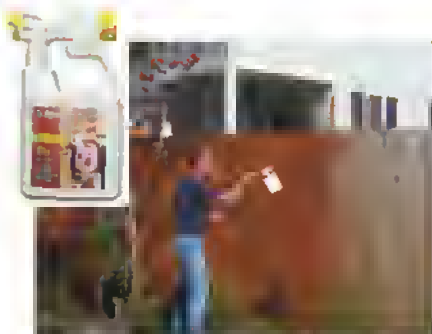
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A BRIEF HISTORY OF THE... **Lawnmower**

Tracing the lawnmower's well-manicured history, from push reels to robotic landscapers—the whole nine yards. **BY JOE P. HASLER**

Start here!



○ **1830**

"Gentlemen will find using my machine an amusing... healthful exercise." — BRITISH MECHANIC EDWIN BUDDING'S PATENT APPLICATION FOR THE FIRST LAWNMOWER

○ **1921**

Knud and Oscar Jacobsen introduce a mower with a purpose-built gas engine. The reel-mowing machine cuts a blistering 4 acres a day—perfect for the golf courses, parks, and cemeteries it's intended to maintain.

○ **1938**

Toro launches a power mower for the homeowner. It's affordable, fits in a garage, and is so easy to handle that parents make their kids use it.

○ **1953**

Briggs & Stratton creates the lightweight aluminum engine for mowers. By 1957 it accounts for 80 percent of engines the company ships in the U.S.

○ **1982**

Explicit lawnmower safety standards are implemented—and an ominous label is born.

○ **1987**

The lawnmower takes a star turn in *Can't Buy Me Love*: Nerdy Ronald woos popular Cindy, and the pair head into the sunset on his Snapper riding mower.

○ **1929**

William Beazley builds a power rotary lawnmower with blades that are driven horizontal to the grass rather than perpendicular like traditional reel mowers, creating a very close cut.

○ **1868**

The reel-type spiral-bladed cutter makes its stateside debut via manufacturer Amariah Hills, who receives the first U.S. patent for the machine.

○ **1940s**

"No feature of a suburban residential community contributes as much to the charm and beauty of the individual home and locality as well-kept lawns." — ABE LEVITT, WHO INSTITUTED STRICT LAWN-CARE RULES IN HIS LONG ISLAND DEVELOPMENT, IN A NEWSLETTER TO LEVITTOWN HOMEOWNERS



Nice pants! In the '70s, kids mow for cash.



○ **2000**

Two companies debut robotic mowers. "Who needs to pay a kid to mow your lawn?" asks *POPULAR MECHANICS* in September.

2010: The world record for fastest speed on a mower is set on May 23 in Pendine, U.K.: 87.83 mph.

2012

Black & Decker releases a new cordless electric mower with fast charge and extra batteries—enough juice for marathon yard maintenance. Husqvarna's Automower 305 even returns to a dock to charge itself. Bow to our future robot overlords!



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